

# **FINAL REPORT**

## **DETERMINATION OF PARTICULATE& DUST CONCENTRATION DURING SHIPYARD DRYDOCK SANDBLASTING OPERATIONS**

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**In behalf of**

**SNAME Ship Production Committee Panel SP-1  
on  
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**Under the**

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PARTICULATE EMISSIONS DURING  
A SHIP SANDBLASTING OPERATION  
NORFOLK SHIPBUILDING AND REPAIR CORPORATION  
NORFOLK, VIRGINIA**

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## **1.0 INTRODUCTION**

Testing was performed to determine the concentrations of total suspended particulate (TSP) and particulate matter smaller than 10 microns ( $PM_{10}$ ) during a typical sandblasting operation. Testing was conducted at the Norfolk Shipbuilding and Drydock Corporation (Norshipco) located in Norfolk, Virginia, on July 14-15, 1992 under the direction of Thomas Beacham of Norshipco. Sampling was conducted by Patrick Slater and Everett Poore of Industrial & Environmental Analysts, Inc. (IEA) Research Triangle Park, North Carolina. Testing was observed by Ms. Lural Driver and Mr. Roy Huntley of the U.S. Environmental Protection Agency (EPA). Gravimetric analysis was performed by Clean Air Engineering (CAE) Analytical Services. Polarized Light Microscopy (PLM) and Scanning Electron Microscopy with Energy Dispersive X-Ray Spectroscopy (SEM-EDX) analyses were performed by IEA, Inc., North Billerica, Massachusetts.

A discussion of the project and sandblasting process is presented in Section 2. A summary and discussion of sampling results is included in Section 3. Sampling and analytical procedures are discussed in Section 4. Quality assurance/quality control (QA/QC) procedures are presented in Section 5. All field data, chain-of-custody forms, laboratory data, field logs, and equipment calibrations are included in the appendices.

## 2.0 PROJECT DESCRIPTION

The U.S. Environmental Protection Agency (EPA) is in the process of developing a control technology guidance document (CTG) for the shipbuilding and repair industry. This document is to address the control of particulate matter smaller than 10 microns ( $PM_{10}$ ) generated during the sandblasting of ships while in drydock.

The purpose of the test program was to determine: 1) whether  $PM_{10}$  dust is generated during a sandblasting operation, 2) if so, what concentrations exist, and 3) the major constituents of the dust.

### 2.1 Drydock Area

Testing was performed at locations in a large floating drydock, approximately 950 feet long, 192 feet wide, and 55 feet deep. The U. S.N.S. Humphreys was placed in the drydock, supported by concrete/wood pillars. The ship was supported approximately 4-5 feet above the drydock floor, and approximately 10-15 feet from each of the two drydock walls. The two ends of the drydock were open.

Large tarps, constructed of 100% fire retardant polypropylene, were draped from the walls of the drydock to the sides of the ship. Tarps also covered the open ends of the drydock. Photos 2.1A and 2.1B shows the U. S.N.S. Humphreys in drydock with the dust control tarps in place.

### 2.2 Sandblasting Operation

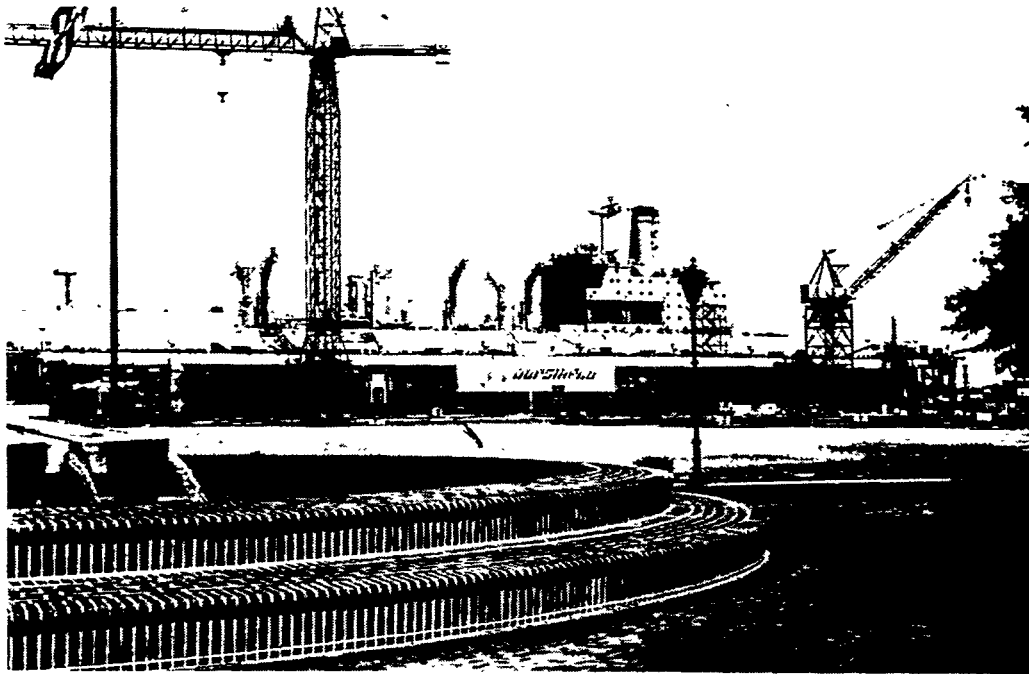
Sandblasting of the ship was performed between 18:00 July 14 and 06:30 July 15, 1992. Testing was performed from 22:00 July 14 to 03:00 July 15. An average of 32 sandblasters were working during the sampling period. An average of 32,340 pounds of blasting material per hour was consumed during the monitoring period, resulting in approximately 8,600 square feet of paint removed. Table 2.2.1 summarizes the number of blasting nozzles in use and pounds of blasting material used during the test period.

Sandblasters were supported by hydraulic man-lifts to within 2 feet of the ship (Photo 2.2A). The pressure at the blasting nozzle was an average 99 pounds per square inch (p.s.i.). **Two blasting agents were utilized, labelled 'Norshipco' and 'ACC'.** Both blasting agents were virtually identical, showing major amounts of aluminum, silicon, and iron, with smaller amounts of potassium and calcium. Both agents appear to be a glass product, having both characteristic optical properties and particle morphology.

Particle sizing on the virgin blasting grits was performed. Table 2.2.2 presents the results of this analysis. The highest percentage (by weight) of both grits have effective diameters of 1 millimeter or greater.

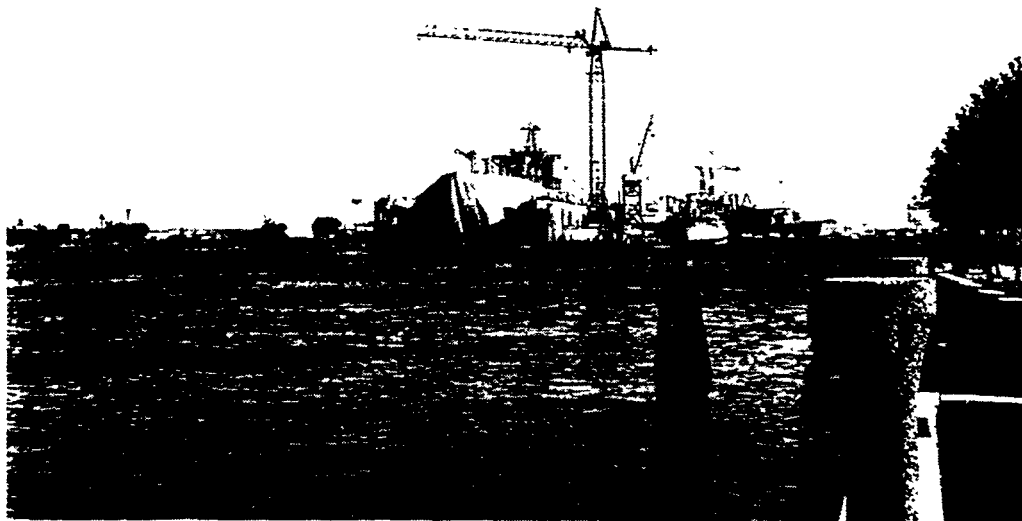
Photograph 2.1A

U. S.N.S Humphreys in drydock with dust control tarps in place.



Photograph 2.1B

U.S.N.S Humphreys in drydock with dust control tarps in place.





**TABLE 2.2.1**  
**Summary of Blasting Operation Conditions**  
**Norfolk Shipbuilding and Repair Corporation**  
**Norfolk, Virginia**

<b>Time</b>	<b>Number of sandblasters</b>	<b>Pounds of Blast Grit used ( l b s )</b>	<b>Average Pressure at Select Blasting Nozzles (p.s.i.)</b>
<b>18:00</b>	<b>28</b>	<b>16,968</b>	
20:00	35	16,954	90
20:30	35	14,700	
21:00	32	14,700	95
21:30	32	14,700	
22:00	32	14,700	110
22:30	32	14,700	
23:00	32	14,700	105
23:30	0	0	
24:00	32	14,700	85
00:30	32	14,700	
01:00	32	14,700	100
01:30	32	14,700	
02:00	32	14,700	105
02:30	32	14,700	
03:00	32	14,700	95
03:30	32	14,700	
0400	32	14,700	90
04:30	32	14,700	
05:00	32	14,700	100
05:30	32	14,700	
06:00	32	14,700	110
06:30	32	14,700	

**Photograph 2.2A**  
**Sandblaster on Man-Lift**  
**U. S.N.S. Humphreys**



**TABLE 2.2.2**  
**Particle Size Analysis of Blasting Grits**  
**Norfolk Shipbuilding and Repair Corporation**  
**Norfolk, Virginia**

<b>Equivalent Particle Diameter</b>	<b>ACC Blasting Grit (Weight %)</b>	<b>Norshipco Blasting Grit (Weight %)</b>
> 1 m m	46.9	86.1
0.5mm to 1mm	25.8	11.2
250μ to 0.5MM	8.3	1.6
105μ to 250μ	11.3	0.9
48μ to 105μ	6.1	0.2
Less than 48μ	1.6	0.1

### 2.3 Sample Locations

A total of five(5) sample locations were chosen to evaluate the sandblasting operation based on recommendations from the U.S. EPA, Norshipco, and IEA. One additional location was chosen to determine the ambient background concentration of both TSP and PM<sub>10</sub>. A description of the sample locations is presented in Table 2.3.1. Figure 2.3.1 presents a schematic representation of the sample locations surrounding the sandblasting operation.

The background samples were collected from 18:30 July 13 to 18:30 July 14, 1992 (24 hour samples). Sampling at the five locations surrounding the drydock area varied from 5 minutes to 15 minutes, depending upon the anticipated particulate loading.

**TABLE 2.3.1**  
**Description of Sample Locations**  
**Norfolk Shipbuilding and Repair Corporation**  
**Norfolk, Virginia**

<b>Sample Location</b>	<b>D e s c r i p t i o n</b>
1	Ambient Background Sample - collected at Norshipco Warehouse approximately 1 mile northeast of drydock area.
2	Located on north side of wing wall, outside the dust-control tarp, approximately 3-4 feet from the tarp.
3	Located on middle landing of stairway leading to the top of the north wing wall. Approximately 12 feet above drydock floor. Shielded from the east by the drydock wall. North and south sides of landing open to atmosphere. No dust control tarp between landing and ship.
4	On drydock floor, within blasting area. Approximately 10 feet from drydock wall, and 15 feet from ship.
5	On drydock floor, within blasting area. Approximately 10 feet from drydock wall, and 15 feet from ship.
6	On drydock floor, midships. Appnimately 5 feet tim drydock wall and 6-8 feet from ship.

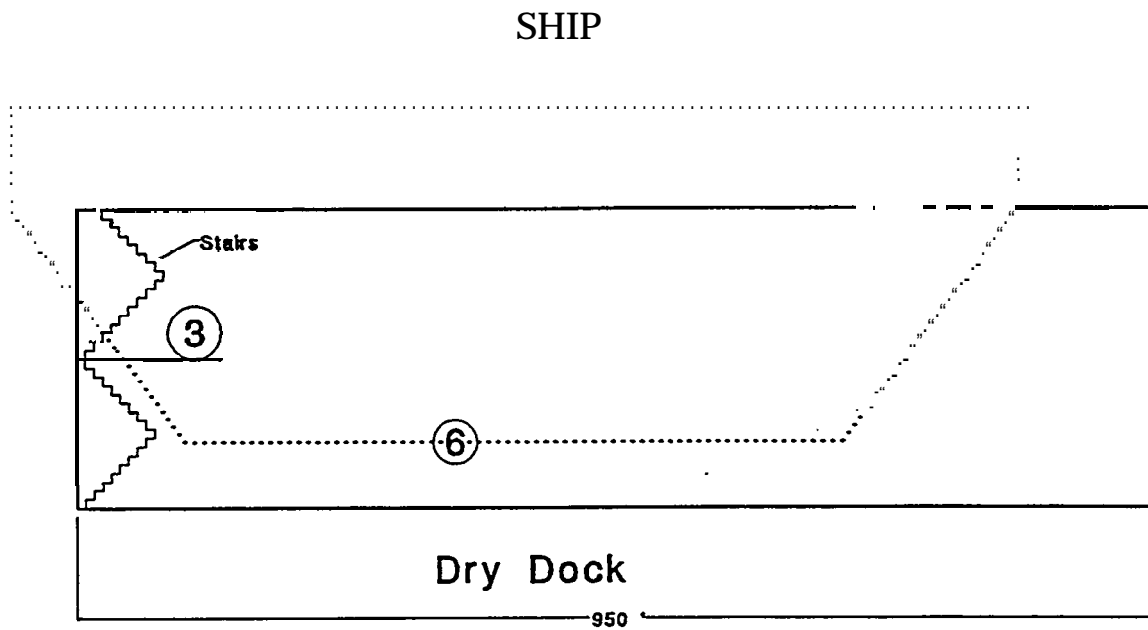
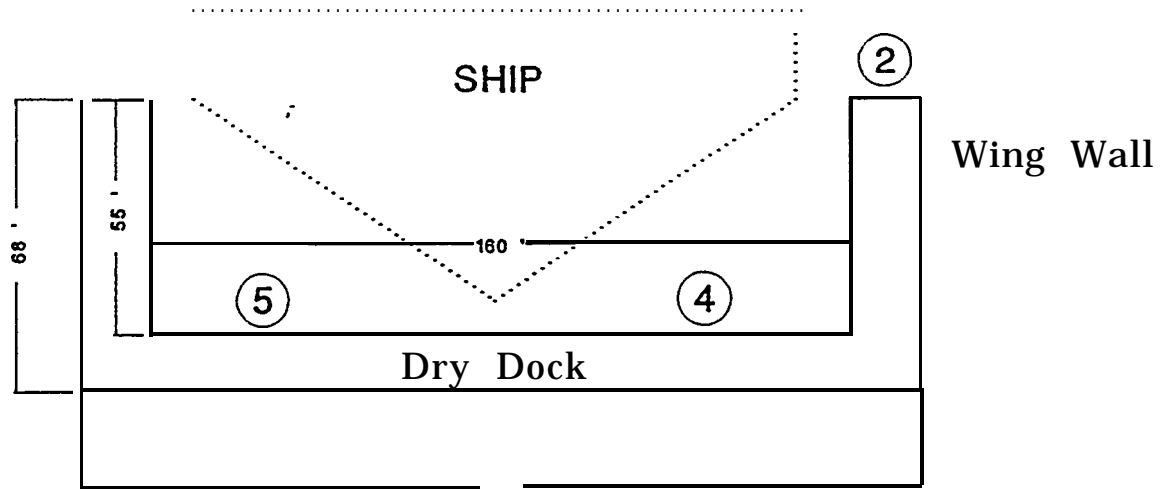


Figure 2.3.1  
Sample Locations  
U.S.N.S. Humphreys

### 3.0 SUMMARY AND DISCUSSION OF RESULTS

#### 3.1 Gravimetric Results

Table 3.1.1 presents a summary of the gravimetric results of all samples collected. Table 3.1.2 presents a summary of all laboratory and field trip blank filters. Table 3.1.3 summarizes the TSP and PM<sub>10</sub> concentrations observed at each of the locations.

TSP concentrations ranged from a low of 6.42 mg/m<sup>3</sup> at location 2 (11 :55pm) to a high of 110 mg/m<sup>3</sup>, also at location 2 (10:23pm). PM<sub>10</sub> concentrations ranged from 1.99 mg/m<sup>3</sup> at Location 2 (11 :55pm) to 52.0 mg/m<sup>3</sup> at Location 4 (2: 00am). The low dust concentration at 11:55pm can be attributed to the reduced number of sandblasters working at that time (see Table 2.2.1). The percentage of PM<sub>10</sub> dust present ranged from a low of 18 % at Locations 2 and 3 (10:30pm and 12:00am respectively) to a high of 93 % at Location 2 (10:45pm). The low percentage of PM<sub>10</sub> at Location 6 (29 %) could be due to the close proximity of the sandblasters. It would be expected that the larger particles would settle in this short distance, while the PM<sub>10</sub> particles would tend to stay airborne for a longer period of time, and thus be carried past the sampling locations by the air currents.

Filter contamination (field trip blanks) ranged from 0.0038g to 0.0250g. This was due to the extremely high concentration of dust in the areas. Because of the variability of this filter contamination samples were not blank corrected. This contamination also contributed to the variability in %PM<sub>10</sub> concentrations at the various locations, possibly higher PM<sub>10</sub> measurements than were actually present.

**TABLE 3.1.1**  
**Particulate Matter Concentrations**  
**Norfolk Shipbuilding and Repair Corporation**  
**Norfolk, Virginia**

Sample Location	Run ID	Sample Type	Time on	Total Sample Time (min)	Total grams collected (g)	Sample Flow Rate (m <sup>3</sup> /min]	Sample Conc. (mg/m <sup>3</sup> )
1	A	TSP	18:00	1,505	0.1877	1.251	0.10
1	B	PM <sub>10</sub>	18:03	1,499	0.1354	1.443	0.06
2	A	TSP	22:00	15	1.2766	1.303	65.8
2	B	PM <sub>10</sub>	22:02	15	0.3607	1.443	16.4
2	c	TSP	22:23	11	1.426	1.303	110
2	D	PM <sub>10</sub>	22:21	10	0.2778	1.443	19.8
2	E	TSP	22:35	10	0.2789	1.303	21.4
2	F	PM <sub>10</sub>	22:33	10	0.2789	1.416	19.9
2	G	TSP	—	—	VOID	—	Tom Filter
2	H	PM <sub>10</sub>	—	—	VOID	—	Tom Filter
2	I	TSP	23:55	10	0.0835	1.303	6.42
2	J	PM <sub>10</sub>	23:55	10	0.0278	1.416	1.99
3	A	TSP	23:41	10	0.4436	0.971	44.4
3	B	PM <sub>10</sub>	23:37	10	0.4192	1.521	28.0
3	C	TSP	23:54	10	0.4320	0.971	43.2
3	D	PM <sub>10</sub>	23:53	10	0.1240	1.567	7.75
4	A	TSP	—	—	VOID	—	Torn Filter
4	B	PM <sub>10</sub>	—	—	VOID	—	Tom Filter
4	C	TSP	02:08	5	0.6563	1.361	93.8
4	D	PM <sub>10</sub>	02:09	5	0.3639	1.331	52.0
5	A	TSP	02:20	5	0.2858	1.521	35.7
5	B	PM <sub>10</sub>	02:21	5	0.1124	0.971	22.5
6	A	TSP	02:45	5	0.2447	1.361	35.0
6	B	PM <sub>10</sub>	02:45	5	0.0715	1.490	10.2

**TABLE 3.1.2**  
**Laboratory and Field Blank Filter Analysis**  
**Norfolk Shipbuilding and Repair Corporation**  
**Norfolk, Virginia**

<b>Sample Location</b>	<b>Blank Type</b>	<b>Total Grams Present (g)</b>
2	Field	0.0038
4	Field	0.0194
5	Field	0.0250
6	Field	0.0072
66-205	Lab	0.0010
66-215	Lab	0.0001
66-216	Lab	-0.0001
66-217	Lab	0.0000

**TABLE 3.1.3**  
**Comparison of TSP and PM<sub>10</sub> Particulate Concentrations**  
**Norfolk Shipbuilding and Repair Corporation**  
**Norfolk, Virginia**

<b>Sample Location</b>	<b>TSP Concentration (mg/m<sup>3</sup>)</b>	<b>PM<sub>10</sub> Concentration (mg/m<sup>3</sup>)</b>	<b>% PM<sub>10</sub></b>
1	0.10	0.06	60%
2	65.8	16.4	25%
2	110	19.8	18%
2	21.4	19.9	93%
2	6.42	1.99	31%
3	44.4	28.0	63%
3	43.2	7.75	18%
4	93.8	52.0	55%
5	35.7	22.5	63%
6	35.0	10.2	29%



### 3.2 Microscopy Analysis Results

Table 3.2.1 presents summary of the PLM analysis of select  $PM_{10}$  filters. Table 3.2.2 presents a summary of the PLM analysis of select TSP filters.

The results from the microscopic analysis indicate that the majority of both the TSP and  $PM_{10}$  particulate generated during the sandblasting operation can be attributed to the blasting grit, and not the paint or metal from the ship. This conclusion is also supported by the SEM-EDX analysis which shows that the major chemical components are aluminum and silicon, both present only in the blasting grits.

A comparison of the 'Mean Diameter' field of Tables 3.2.1 and 3.2.2 indicates that the size selective inlet (SSI) of the  $PM_{10}$  sampler was able to effectively restrict the particles greater than 10 microns from reaching the filter. Table 3.2.3 shows an average particle analysis of three  $PM_{10}$  filters. The average mean diameter of these three filters was 10.7 microns.

In-field verification of the effectiveness of the  $PM_{10}$  SSI can be seen on the greased shim plate. (See Section 4.2.2 for description of the  $PM_{10}$  sampler.) Photograph 3.2A shows a  $PM_{10}$  greased shim plate with regular circular patterns, which indicates no entrainment of particles greater than  $PM_{10}$ .

Photograph 3.2B, however, shows a  $PM_{10}$  greased shim plate with obvious streaking of the larger particles, indicating possible entrainment of these larger particles onto the  $PM_{10}$  filter. This effect would bias the weight of the  $PM_{10}$  filter high, since particles larger than  $PM_{10}$  would be present.

Photograph 3.2B is of the  $PM_{10}$  sampler used at Location 5. This would indicate a higher  $PM_{10}$  filter weight, as well as a higher average mean diameter of particles on the filter. This is supported by the PLM analysis of the Location 5  $PM_{10}$  filter which did show a higher average mean diameter of particles present (see Table 3.2.1).

**TABLE 3.2.1**  
**Polarized Light Microscopy Analysis - PM<sub>10</sub> Filters**  
**Norfolk Shipbuilding and Repair Corporation**  
**Norfolk, Virginia**

<b>Sample Location</b>	<b>Particle Type</b>	<b>Weight %</b>	<b>Number %</b>	<b>Mean Diameter (μ)</b>	<b>Density</b>
<b>1B</b>	<b>Minerals</b>	<b>36</b>	<b>44</b>	<b>7</b>	<b>2.6</b>
	<b>Opakes</b>	<b>21</b>	<b>29</b>	<b>7</b>	<b>1.5</b>
	<b>Blast Grit</b>	<b>8</b>	<b>6</b>	<b>8</b>	<b>2.6</b>
	<b>Biologicals</b>	<b>36</b>	<b>21</b>	<b>8</b>	<b>1.5</b>
<b>2B</b>	<b>Minerals</b>	<b>1</b>	<b>3</b>	<b>8</b>	<b>2.6</b>
	<b>Opakes</b>	<b>5</b>	<b>25</b>	<b>7</b>	<b>1.5</b>
	<b>Blast Grit</b>	<b>93</b>	<b>70</b>	<b>10</b>	<b>2.6</b>
	<b>Biological</b>	<b>&lt;1</b>	<b>2</b>	<b>6</b>	<b>1.5</b>
<b>2D</b>	<b>Minerals</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2.6</b>
	<b>Opakes</b>	<b>12</b>	<b>32</b>	<b>8</b>	<b>1.5</b>
	<b>Blast Grit</b>	<b>87</b>	<b>67</b>	<b>10</b>	<b>2.6</b>
	<b>Biological</b>	<b>1</b>	<b>1</b>	<b>10</b>	<b>1.5</b>
<b>3D</b>	<b>Minerals</b>	<b>2</b>	<b>2</b>	<b>9</b>	<b>2.6</b>
	<b>Opakes</b>	<b>11</b>	<b>36</b>	<b>7</b>	<b>1.5</b>
	<b>Blast Grit</b>	<b>86</b>	<b>61</b>	<b>9</b>	<b>2.6</b>
	<b>Biological</b>	<b>2</b>	<b>1</b>	<b>15</b>	<b>1.5</b>
<b>4D</b>	<b>Minerals</b>	<b>1</b>	<b>3</b>	<b>6</b>	<b>2.6</b>
	<b>Opakes</b>	<b>15</b>	<b>35</b>	<b>8</b>	<b>1.5</b>
	<b>Blast Grit</b>	<b>85</b>	<b>62</b>	<b>8</b>	<b>2.6</b>
	<b>Biological</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1.5</b>
<b>5B</b>	<b>Minerals</b>	<b>4</b>	<b>4</b>	<b>14</b>	<b>2.6</b>
	<b>Opakes</b>	<b>24</b>	<b>39</b>	<b>12</b>	<b>1.5</b>
	<b>Blast Grit</b>	<b>72</b>	<b>57</b>	<b>13</b>	<b>2.6</b>
	<b>Biological</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1.5</b>
<b>6B</b>	<b>Minerals</b>	<b>11</b>	<b>8</b>	<b>9</b>	<b>2.6</b>
	<b>Opakes</b>	<b>27</b>	<b>49</b>	<b>8</b>	<b>1.5</b>
	<b>Blast Grit</b>	<b>58</b>	<b>40</b>	<b>10</b>	<b>2.6</b>
	<b>Biologicals</b>	<b>4</b>	<b>3</b>	<b>10</b>	<b>1.5</b>

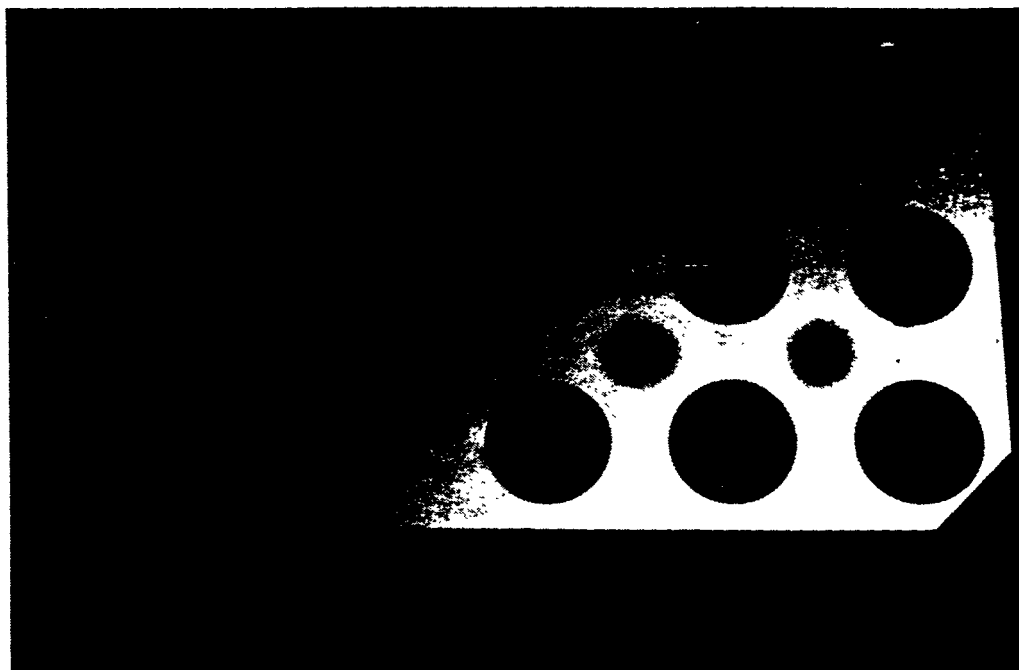
**TABLE 3.2.2**  
**Polarized -Light Microscopy Analysis - TSP Filters**  
**Norfolk Shipbuilding and Repair Corporation**  
**Norfolk, Virginia**

<b>Sample Location</b>	<b>Particle Type</b>	<b>Weight %</b>	<b>Number %</b>	<b>Mean Diameter (μ)</b>	<b>Density</b>
<b>2C</b>	<b>Minerals</b>	<b>&lt;1</b>	<b>3</b>	<b>10</b>	<b>2.6</b>
	<b>Opakes</b>	<b>27</b>	<b>46</b>	<b>15</b>	<b>1.5</b>
	<b>Blast Grit</b>	<b>72</b>	<b>51</b>	<b>18</b>	<b>2.6</b>
	<b>Biological</b>	<b>0</b>	<b>0</b>	<b>10</b>	<b>1.5</b>
<b>3C</b>	<b>Minerals</b>	<b>&lt;1</b>	<b>3</b>	<b>11</b>	<b>2.6</b>
	<b>Opakes</b>	<b>7</b>	<b>37</b>	<b>12</b>	<b>1.5</b>
	<b>Blast Grit</b>	<b>91</b>	<b>59</b>	<b>17</b>	<b>2.6</b>
	<b>Biological</b>	<b>1</b>	<b>1</b>	<b>25</b>	<b>1.5</b>
<b>4C</b>	<b>Minerals</b>	<b>&lt;1</b>	<b>1</b>	<b>20</b>	<b>2.6</b>
	<b>Opakes</b>	<b>13</b>	<b>22</b>	<b>53</b>	<b>1.5</b>
	<b>Blast Grit</b>	<b>87</b>	<b>77</b>	<b>60</b>	<b>2.6</b>
	<b>Biological</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1.5</b>
<b>5A</b>	<b>Minerals</b>	<b>1</b>	<b>2</b>	<b>19</b>	<b>2.6</b>
	<b>Opakes</b>	<b>5</b>	<b>18</b>	<b>16</b>	<b>1.5</b>
	<b>Blast Grit</b>	<b>90</b>	<b>78</b>	<b>20</b>	<b>2.6</b>
	<b>Biological</b>	<b>3</b>	<b>2</b>	<b>33</b>	<b>1.5</b>
<b>6A</b>	<b>Minerals</b>	<b>&lt;1</b>	<b>5</b>	<b>9</b>	<b>2.6</b>
	<b>Opakes</b>	<b>10</b>	<b>17</b>	<b>15</b>	<b>1.5</b>
	<b>Blast Grit</b>	<b>89</b>	<b>78</b>	<b>18</b>	<b>2.6</b>
	<b>Biological</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1.5</b>

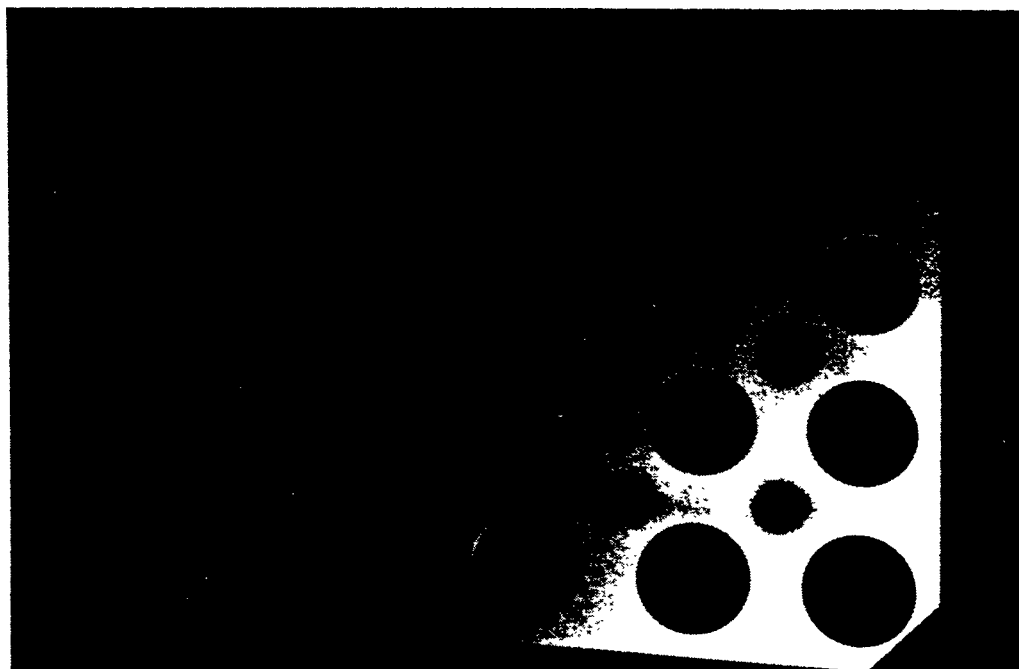
**Table 3.2.3**  
**PLM Particle Size Analysis - PM<sub>10</sub> Filters**  
**Norfolk Shipbuilding and Repair Corporation**  
**Norfolk, Virginia**

<b>Sample Location</b>	<b>Mean Particle Diameter (P)</b>
<b>2F</b>	<b>11</b>
<b>3B</b>	<b>12</b>
<b>n</b>	<b>9</b>

Photograph 3.2A  
PM10 Greased Shim Plate - No Particle Trailing



Photograph 3.2B  
PM10 Greased Shim Plate - Particle Trailing



### 3.3 Meteorological Results

Meteorological conditions during sampling were recorded by Norshipco. A comparison of sample concentrations and meteorological conditions is presented in Table 3.3.1. Since the required sampling time varied from 5 to 15 minutes (due to rapid filter loading), a definitive effect on sample concentrations by Changing meteorological renditions can not be determined.

TABLE 3.3.1  
Comparison of Sample Concentrations and Meteorological Conditions  
Norfolk Shipbuilding and Repair Corporation  
Norfolk, Virginia

Sample Location	Run ID/ Sample Type	Time On	Sample Cone (mg/m <sup>3</sup> )	Wind Direct.	Wind Speed (knots)	Temp (°F)	% Rel. Humidity
1	A-TSP	18:00	0.10	w	10	95	40
1	B-PM <sub>10</sub>	18:03	0.06	w	10	95	40
2	A-TSP	22:00	65.8	w	10	89	48
2	B-PM <sub>10</sub>	22:02	16.4	w	10	89	48
2	C-TSP	22:23	110	w	11	88	67
2	D-PM <sub>10</sub>	22:21	19.8	w	11	88	67
2	E-TSP	22:35	21.4	w	11	88	67
2	F-PM <sub>10</sub>	22:33	19.9	w	11	88	67
2	I-TSP	23:55	6.42	w	10	87	66
2	J-PM <sub>10</sub>	23:55	1.99	w	10	87	66
3	A-TSP	23:41	29.6	w	8	88	67
3	B-PM <sub>10</sub>	23:37	41.9	w	8	88	67
3	C-TSP	23:54	27.0	w	10	87	66
3	D-PM <sub>10</sub>	23:53	12.4	w	10	87	66
4	C-TSP	02:08	93.8	w	10	84	76
4	D-PM <sub>10</sub>	02:09	52.0	w	10	84	76
5	A-TSP	02:20	35.7	w	10	84	76
5	B-PM <sub>10</sub>	02:21	22.5	w	10	84	76
6	A-TSP	02:45	35.0	w	13	84	80
6	B-PM <sub>10</sub>	02:45	10.2	w	13	84	80

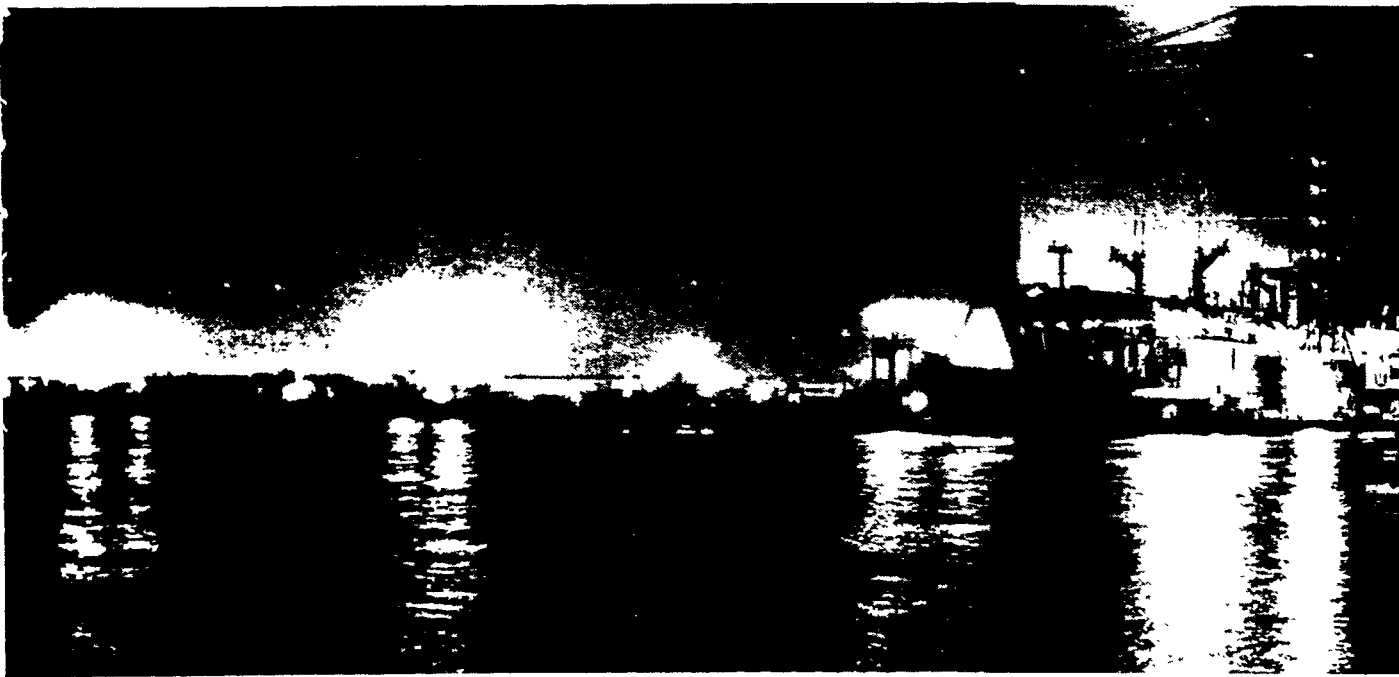
### 3.4 Summary

Due to the extremely high concentrations of total suspended particulate in the locations sampled, accurate TSP and PM<sub>10</sub> results were difficult to obtain. A more accurate determination of the PM<sub>10</sub> generated requires sampling for longer periods of time than was possible at the locations selected, due to rapid loading of the filters and > PM<sub>10</sub> shim plate. In addition, the excessive contamination of filters due to the high area dust concentrations did not allow for accurate PM<sub>10</sub> measurements.

The results of this study indicate that PM<sub>10</sub> dust is generated during the sandblasting operation. The concentrations of PM<sub>10</sub> dust found at the areas monitored ranged from 1.99 mg/m<sup>3</sup> to 52 mg/m<sup>3</sup>, or from 18% to 93% of the total suspended particulate concentrations. The significant constituent of both the total and PM<sub>10</sub> dusts was the blasting grit. The percentage of paint found in both the TSP and PM<sub>10</sub> samples comprised only 5 to 27% (by weight) of the samples collected. Smaller amounts of minerals (e.g. ship metal, rust) were present.

PM<sub>10</sub> emissions from the sandblasting operation would be more accurately measured by placing the samplers in the dust plume at locations further from the sandblasting operation. As can be seen in Photograph 3.4A, the dust plume created is capable of travelling a considerable distance. A comparison of the PM<sub>10</sub> concentration present during and after a blasting event would provide a better estimate of the environmental impact, if any, of this type of blasting operation. The percentage of PM<sub>10</sub> present in the samples collected in close proximity to the blasting operation were lower, on average, than the percent of PM<sub>10</sub> found in the background sample.

**Photograph 3.4 A**  
**Dust Plume Generated by Sandblasting Operation**



## 4.0 SAMPLING AND ANALYTICAL PROCEDURES

### 4.1 Airborne Dust Concentrations

#### 4.1.1 Total Suspended Particulate

Sampling and analytical procedures used in this project are contained in 40 CFR Part 50 Appendix B (7-1-89 Edition). Samples were collected using high-volume samplers manufactured by General Metal Works, Inc. (GMW). Figure 4.1.1 shows a schematic of the high volume sampler. The High Volume Air Sampler is the recommended instrument for sampling large volumes of air for the collection of suspended particulate matter. The physical design of the sampler is based on aerodynamic principles which result in the collection of particles of 100 microns (Stokes Equivalent Diameter) and less. The sampler consists of a supporting screen for the filter in front of the blower/motor unit. During operation, the sampler is supported in a protective shelter so that the 8" x 10" surface of the filter is in a horizontal position approximately 3 feet above the floor. In its basic configuration, as used in this project, the sampler (Model GMWT 2200) is equipped with a flow meter connected to a pressure tap at the exhaust end of the motor. The sampler was modified to incorporate a programmable timer and continuous flow device for recording the flow rate over the entire sampling period.

#### 4.1.2 PM<sub>10</sub>

PM<sub>10</sub> particles were collected using high-volume samplers manufactured by GMW equipped with a size selective inlet (SSI). Figure 4.1.2 shows a schematic of the high volume sampler equipped with the SSI. Particles enter the SSI through the symmetrical inlet, and are accelerated through multiple circular impactor nozzles. The base under the first set of nozzles is sprayed with Dow Silicone 361 grease. Particles greater than 10 microns impact with this greased impaction surface. The particles smaller than 10 microns are carried upward by the air flow, and then down through the multiple vent tubes to the 8" x 10' falter.

### 4.2 Filter Analysis

#### 4.2.1 Gravimetric

The falters were standard glass fiber falters measuring 8" x 10". All falters were pre-tared by CAE Analytical Services. After sampling, the falters were put in foil pouches, replaced in their original envelopes, and post-weighed by CAE. The difference in the pre- and post-tare weights represents the mass of particulate collected.



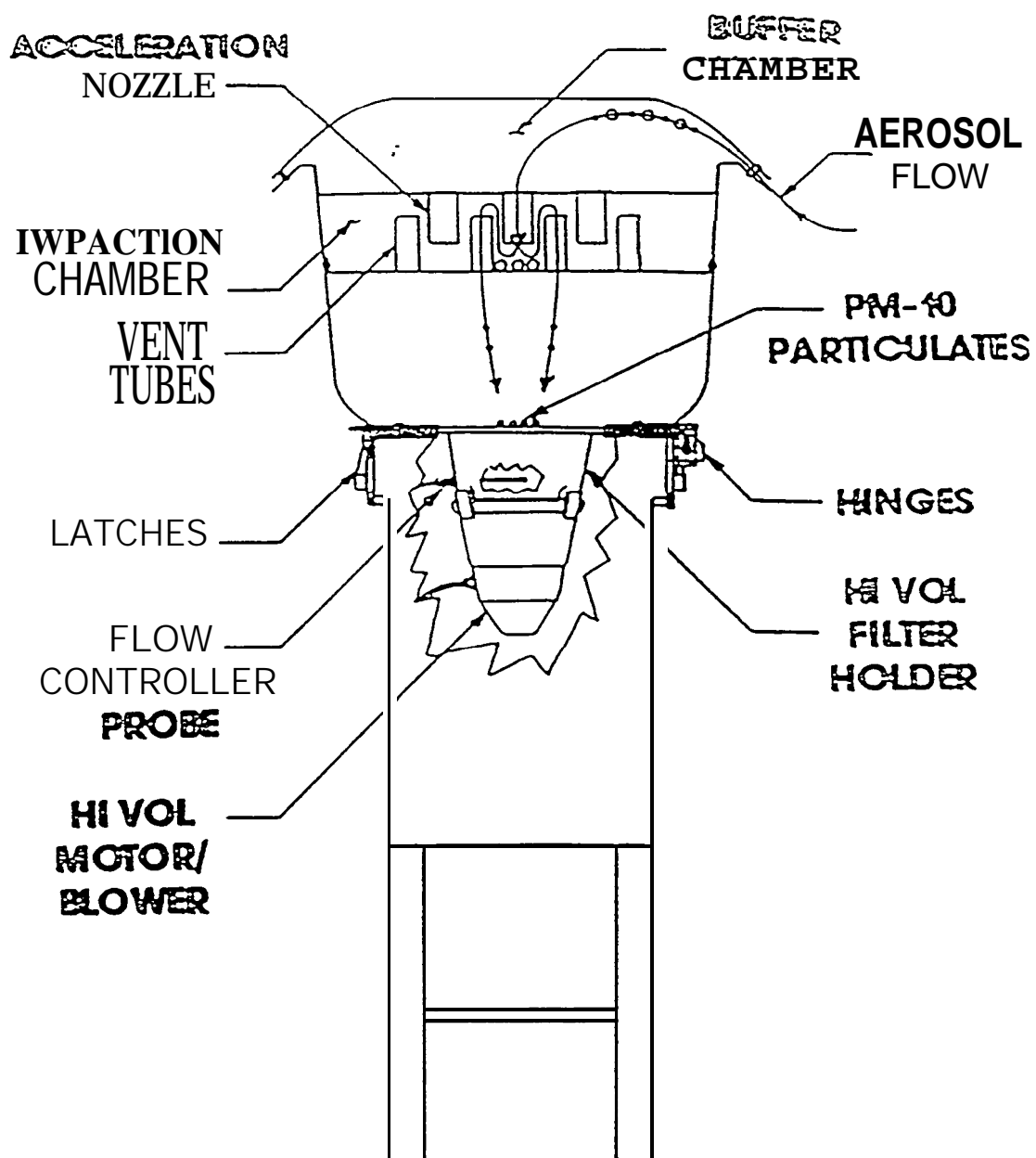


Figure 4.1.2  
PM 10 High Volume Sampler

Several blank filters were also submitted for analysis. Laboratory blank filters were filters which were not-removed from their original envelope. Trip blank filters were filters placed in the filter cassettes, taken to the sample location, placed in the sampler, and then removed and placed back into the original envelope. Laboratory data is presented in Appendix C. The total mass collected (in milligrams, mg) divided by the **standard** sample volume (in standard cubic meters, m<sup>3</sup>) represents the particulate concentration for the sample location (mg/m<sup>3</sup>).

#### **4.2.1 Polarized Light Microscopy (PLM)**

For PLM analysis, a portion of the sample was transferred to a microscope slide, immersed in oil, and examined using standard PLM techniques. This analysis was able to classify the dust collected into four categories: minerals, opaques, blast grit, and biologicals. The 'minerals' category included any birefringent angular to rounded particles. These particles could be transparent, or colorless to strongly colored. The 'opaques' category included all opaque (black) particles, plus any translucent particles which were recognizable as paint or rust. The 'blast grit' category included particles which were transparent, isotropic, colorless to green-brown and always very angular. The blast grit particles occasionally exhibited inclusions and frequently showed conchoidal fractures. The 'biological' category includes spores, pollens, and vegetable fibers.

#### **4.2.2 Scanning Electron Microscopy with Energy Dispersive X-Ray Spectroscopy (SEM-EDX)**

Select filters were analyzed by SEM-EDX in order to compare the dust composition with the composition of the blast grits and paint samples from the U. S.N.S. Humphreys. Samples were excited by a beam of incident radiation. The sample then emitted x-rays which were detected by a cryogenically cooled lithium drifted silicon detector. The energy proportional signal for each individual x-ray which transmits the detector was digitized and stored in a multi-channel pulse-height analyzer. A qualitative spectrogram is produced, which was used to identify the elements present. Spectrograms are presented in Appendix C.

## 5.0 QA/QC PROCEDURES

The objective of a quality assurance/quality control (QA/QC) program is to assure that the precision and accuracy of all environmental data generated by IEA, Inc. is commensurate with the data quality objectives (DQOs) of Norshipco. DQOs are based on a common understanding of the intended end use(s) of the data, the measurement process, and the availability of resources. Once DQOs are established, formally or informally, QA protocol can be defined for the measurements. The data quality objectives in this project are to provide information to Norshipco and the U.S. EPA regarding the concentrations and composition of TSP and PM<sub>10</sub> dust generated during a sandblasting event.

The goal of a QA/QC program is to ensure that data generated and used for decision-making are scientifically sound, of known quality, and documented to be "in control". To accomplish this goal, standardize methods or procedures are used whenever possible. They must be validated for their intended use, rigorously followed, and data reported with quality indicators (precision, accuracy, completeness, etc.).

Two basic concepts used in a QA program are to:

1. Control errors.
2. Verify that the entire sampling and analytical methods are operating within acceptable performance limits.

Use of qualified personnel, reliable and well-maintained equipment, appropriate calibrations and standards, and close supervision of all operations are important components of the QA system. QA in this test program included the use and documentation of calibrated sampling and analytical instruments, use of EPA validated methods (EPA 40 CFR Part 50 Appendix B), adherence to established protocol, method blanks as a check against possible contamination, sample chain-of-custody documentation, and redundant data calculation with checking.

### 5.1 **High-Volume Samplers**

The Hi-Vol samplers were calibrated prior to sampling. The blower/motor unit of each sampler is designed to compensate for any additional pressure drop due to particulate collection and maintain a constant flow rate of 40 cubic feet per minute. A continuous chart recorder which monitored the pressure drop across the unit was added to each sampler. Calibration was confirmed in the field using a calibration orifice whenever the indicated flow rate varied by more than ten percent (10%). The actual sampling rate combined with the sample time allowed calculation of the total volume sampled. Barometric pressure, ambient temperature, and relative humidity were recorded constantly by the Norshipco meteorological station. The volume of air collected (m<sup>3</sup>) at standard conditions (298 K, 760 mmHg) was calculated. Example calculations are provided in Appendix A. Calibration data are presented in Appendix E.

## 5.2 Filter Analysis

Gravimetric analysis was performed by clean Air Engineering (CAE) according to the analytical procedures defined in 40 CFR Part 50 Appendix B. Four laboratory filter blanks were provided for gravimetric analysis as a check against potential sample contamination. In addition, four field trip blanks were also analyzed to determine if filter contamination was possible by simply transporting the filter to the sampler location. Chain-of-custody sheets are provided in Appendix C. No absolute accuracy for this method can be defined due to the inability to determine a “true” particulate matter concentration. Based upon collaborative testing, the relative standard deviation (coefficient of variation) for a single analyst’s precision (repeatability) of the method is 3.0 percent. The corresponding value for interlaboratory precision is 3.7 percent.

## **Appendix A**

### **Example Calculations**

## EXAMPLE CALCULATIONS

### 1. Sample Flow Rate

$$Q_{std} = \frac{1}{m} (Y - b)$$

Where  $Q_{std}$  = Flow Rate at Standard Conditions, m<sup>3</sup>/min  
 $m$  = Slope of Sampler Calibration Curve  
 $Y$  = Flow Rate Indicated on Sampler Chart Recorder  
 $b$  = Y Intercept of Sampler Calibration Curve

Example: Sample Run 1A

$$Q_{std} = \frac{(1/38.068) \times (42 - (-5.191))}{1.251 \text{ mg/m}^3}$$

### 2. Sample Volume

$$t \times Q_{std} = V_a$$

Where  $t$  = Sample Time in Minutes  
 $Q_{std}$  = Sample Flow Rate (cubic meters per minute)  
= Sample Volume (cubic meters)

Example: Sample Run 1A

$$V_a = \frac{1505 \text{ min} \times 1.251 \text{ m}^3/\text{min}}{1,882 \text{ m}^3}$$

### 3. Sample Concentration

$$\text{Cone (mg/m}^3) = \frac{W_g \times 1,000 \text{ Mg/g}}{V_a}$$

Where:  $W_g$  = Total Particulate Weight, in grams  
 $V_a$  = Sample Volume, in cubic meters

Example: Sample Run 1A

$$\text{Cone} = \frac{(0.1877 \text{ g} \times 1,000)/1,882 \text{ m}^3}{0.10 \text{ mg/m}^3}$$

## **Appendix B**

### **Field Data Summaries and Data Sheets**

# NORSHIPCO Project # 1512-001

## Data Summary

Sample Number	Sampler ID	Indicated Flow (cfm)	Qstd (m3/min)	Sample l i m e (min)	Sample Volume (m3)	Total Weight (g)	Cone. (mg/m3)
1A	4	42	1.251	1505	1883	0.1877	0.10
1B	3	48	1.443	1499	2163	0.1354	0.06
2A	4	44	1.303	15	20	1.2766	63.83
2B	3	48	1.443	15	22	0.3607	16.40
2C	4	44	1.303	10	13	1.4260	109.69
2D	3	48	1.443	10	14	0.2778	19.84
2E	4	44	1.303	10	13	0.2789	21.45
2F	3	47	1.416	10	14	0.2789	19.92
2I	4	44	1.303	10	13	0.0835	6.42
2J	3	47	1.416	10	14	0.0278	1.99
3A	1	52	1.521	10	15	0.4436	29.57
3B	5	37	0.971	10	10	0.4192	41.92
3C	1	54	1.567	10	16	0.4320	27.00
3D	5	36	0.998	10	10	0.1240	12.40
4C	CAE	44	1.361	5	7	0.6563	93.76
4D	2	44	1.331	5	7	0.3639	51.99
5A	1	52	1.521	5	8	0.2858	35.73
5B	5	37	0.971	5	5	0.1124	22.48
6A	CAE	44	1.361	5	7	0.2447	34.96
6B	2	50	1.490	5	7	0.0715	10.21



# HIGH VOLUME AMBIENT SAMPLER DATA SHEET

RH 78%

Sampling Site: warehouse 930  
 Sampler Location: Parking lot  
 Sample No.: 1



	Before	After
Barometric Pressure	<u>29.58</u>	<u>29.57</u>
Ambient Temperature	<u>100.8</u>	<u>94</u>

Site: Norfolk Date: 7/13/92 Performed By: PS/EP

IEA-3

Sampler S/N	Sampling Location I.D.	Height Above Ground	Identification No.		Sampling Period		Total Sampling Time (min)	Pump Timer (hr/min)	Sampler Flow Check*				
			Filter	XAD-2 or PUF	7/13/92 Start	7/14/92 Stop			Manometer ΔH (in. H <sub>2</sub> O)	Qxs	M	Qms	Within +/-10%
<u>4</u>	<u>1-A</u>	<u>36"</u>	<u>66-48</u>	<u>Total</u>	<u>18:00</u>	<u>19:05</u>				<u>42</u>		<u>42</u>	<u>✓</u>
<u>00111</u>	<u>1-B</u>	<u>52"</u>	<u>66-127</u>	<u>PUM10</u>	<u>18:03</u>	<u>19:02</u>				<u>48</u>		<u>49</u>	<u>✓</u>
<u>PM1538</u>													

Must Be Performed Before and After Each Sampling Period

Checked By \_\_\_\_\_  
 Date: 7/19/92

IEA - Temp : 9  
 Barometric : 29.79  
 Humidity : 58%

# HIGH VOLUME AMBIENT SAMPLER DATA SHEET

Met. Station

Sampling Site: Nearshipco  
 Sampler Location: Wingwall - Port Starboard  
 Sample No.: 2



	Before	After
Barometric Pressure		
Ambient Temperature		

Site: Midship - outside shroud Date: 7/14/92 Performed By: PS/EP

Sampler S/N	Sampling Location I.D.	Height Above Ground	Identification No.		Timer Sampling Period		Total Sampling Time (min)	Pump Timer (hr/min)	Sampler Flow Check*				
			Filter	XAD-2 or PUF	Start	Stop			Manometer ΔH (in. H2O)	Qxs	M	Qms	Within +/-10%
(3) IEA-3	1541-011	2A	67-147	TSP	13:03	13:18	15			44		44	22:00 22:15
		2B	67-148	PM10	20:00	20:15	15			48		48	22:02 22:17
(2) IEA-3	1541-011	2C	67-150	TSP	13:27	13:38	11			44		44	22:23 22:24
		2D	67-149	PM10	16:52	17:02	10			48		47	22:21 22:31
(1) IEA-3	1541-011	2E	67-145	TSP	13:39	13:44	10			44		44	22:35 22:45
		2F	67-144	PM10	17:03	17:13	10			47		47	22:33 22:43
IEA-3	1541-011	2G	66-121	TSP	10:00	10:00							
		2H	66-123	PM10	10:00	10:00							
		2I	66-209	TSP	14:35	15:05	10			44		44	11:55 12:05
IEA-3	1541-011	2J	66-203	PM10	18:24	18:34	10			47		47	11:55 12:05
		2K	67-146	Field Blank									

Must Be Performed Before and After Each Sampling Period

Checked By: \_\_\_\_\_  
 Date: \_\_\_\_\_

- (1) slight tear in filter when removing
- (2) " " " " Before
- (3) Two Tears in filter when removing

2I/2J - Plume ~~was~~ much lighter

# **HIGH VOLUME AMBIENT SAMPLER DATA SHEET**

Sampling Site: Norshipco  
 Sampler Location: \_\_\_\_\_  
 Sample No.: \_\_\_\_\_



	Before	After
Barometric Pressure	—	—
Ambient Temperature	—	—

Site: Halfway Deck Date: 7/14/92 Performed By: PS / EP

IEA-1  
 IEA-5  
 IEA-1  
 IEA-5

Sampler S/N	Sampling Location I.D.	Height Above Ground	Identification No.		Sampling Period		Total Sampling Time (min)	Pump Timer (hr/min)	Sampler Flow Check*			
			Filter	XAD-2 or PUF	Start	Stop			Manometer ΔH (in. H <sub>2</sub> O)	Qxs	M	Qms Within +/-10%
00574	3A	3'	66-201	TSP	2341	2351	10	6871		54		52
0109	3B	4'	66-202	PM10	2337	2347	10	4946		36		28
	3C	3'	66-199	TSP	2354	0:04	10	6887		36		36
	3D	4'	66-200	PM10	2353	003	10	4963		54		54

\* Must Be Performed Before and After Each Sampling Period

Checked By: \_\_\_\_\_  
 Date: \_\_\_\_\_

**idea**Ambient Temperature           [illegible]

Checked By \_\_\_\_\_  
Date: \_\_\_\_\_

# HIGH VOLUME AMBIENT SAMPLER DATA SHEET

Sampling Site: Alorshipco  
 Sampler Location: Inside Bow  
 Sample No.: \_\_\_\_\_



Before After  
 Barometric Pressure \_\_\_\_\_  
 Ambient Temperature \_\_\_\_\_

Site: \_\_\_\_\_ Date: 7/1/92 Performed By: PS / EP

CAE  
 IEA-2  
 (1)

Sampler SIN	Sampling Location I.D.	Height Above Ground	Identification No.		Sampling Period		Total Sampling Time (mln)	Pump Timer (hr/mln)	Sampler Flow Check				
			Filter	XAD-2 or PUF	Start	stop			Manometer AH (In. H2O)	Qxs	M	Qms	Within +/- 1 0%
2945	4AC	3'	66-214	PS	0205	0213	4105	1532		44		44	
0112	4AD	4'	66-212	PM-10	0209	0214	4105			44		44	
2945	4S	Field 7/1/92	66-211	TS									

Must Be Performed Before and After Each Sampling Period

Checked By: \_\_\_\_\_  
 Date: \_\_\_\_\_

(1) Discoloration and odors

## HIGH VOLUME AMBIENT SAMPLER DATA SHEET

Sampling Site: Norshipco  
 Sampler Location: Inside Bow (Rt.)  
 Sample No.: \_\_\_\_\_



	Before	After
Barometric Pressure	—	—
Ambient Temperature	—	—

Site: \_\_\_\_\_ Date: 7/15/92 Performed By: PS/EP

Sampler S I N	Sampling Location I.D.	Height Above Ground	Identification No.		Sampling Period		Total Sampling Time (min)	Pump Timer (hr/min)	Sampler Flow Check				
			Filter	XAD-2 or PUF	Start	Stop			Manometer AH (In. H <sub>2</sub> O)	Qxs	M	Qms	Within +/-10%
IEA-1	SA	3'	66-213	TS1	0220	0225	5			5.2		52	
IEA-5	SB	4'	66-210	PM-10	0221	0226	5			38		36	
(1)	SC	Field Blank	66-209	TS1									

Must Be Performed Before and After Each Sampling Period

Checked By \_\_\_\_\_  
 Date: \_\_\_\_\_

(1) Discoloration around edges

# *HIGH VOLUME AMBIENT SAMPLER DATA SHEET*

Sampling Site: Norshipco  
 Sampler Location: mid ship  
 Sample No.: \_\_\_\_\_



	Before	After
Barometric Pressure	—	—
Ambient Temperature	—	—

Site: \_\_\_\_\_ Date: 7/15/92 Performed By: BS/EP

Sampler SIN	Sampling Location I.D.	Height Above Ground	identification		Sampling Period		Total Sampling Time (min)	Pump Timer (hr/min)	Sampler Flow Check				
			No. Filter	XAD-2 or PUF	Start	stop			Manometer AH (in. H2O)	Qxs	M	Qms	Within +/-10%
CAE	6A	2'	66-207	73P	0245	0250	13.5			44		44	
2	6B	4'	66207	73P	0245	0250	13.5			50		50	
	6C	3'	66-206	Field Blank									

Must Be Performed Before and After Each Sampling Period

Checked By \_\_\_\_\_  
 Date: \_\_\_\_\_

## **Appendix C**

### **Laboratory Analysis Data and Chain-of-Custody Documentation**



# Particulate Testing Weight Sheet

Page 1 of 3

Client <u>IEA</u>	Project Number <u>1517-001</u>	Analyst <u>JLP</u>
Plant <u>Norshipco</u>	Unit <u>      </u>	Balance <u>GM2000</u>
Test Date <u>7/14/92</u>		

Description	Wt. No.	I.D. and Sample Description	Sample volume (ml)	Date/Time	Gross Weight (g)	Tare Weight (g)	Date/Time	Net Weight (g)
Type <u>FILTER</u>	<u>1</u>	<u>66 127</u> <u>GRAY PART. STAIN</u> <u>FINES AND</u> <u>26119-01</u>	<u>/</u> <u>T(F)B</u>	<u>7/23 1445</u>	<u>3.6371</u>	<u>3.4827</u>	<u>7/10 1600</u>	<u>0.1554</u>
Run				<u>7/24 1230</u>	<u>3.6179</u>			
Location				<u>7/27 1100</u>	<u>3.6175</u>			
Type <u>FILTER</u>	<u>2</u>	<u>66 148</u> <u>GRAY PART</u> <u>STAIN</u> <u>36119-02</u>	<u>/</u> <u>T(F)B</u>	<u>7/23 1445</u>	<u>3.5086</u>	<u>3.3171</u>	<u>7/10 1720</u>	<u>0.1877</u>
Run				<u>7/24 1240</u>	<u>3.5048</u>			
Location				<u>7/27 1055</u>	<u>3.5047</u>			
Type <u>FILTER</u>	<u>3</u>	<u>66 199</u> <u>FINE GRAY PART.</u> <u>STAIN</u> <u>26119-03</u>	<u>/</u> <u>T(F)B</u>	<u>7/23 1550</u>	<u>3.6805</u>	<u>3.2543</u>	<u>7/10 1725</u>	<u>0.4321</u>
Run				<u>7/24 1215</u>	<u>3.6865</u>			
Location				<u>7/27 1120</u>	<u>3.6868</u>			
Type <u>FILTER</u>	<u>4</u>	<u>66 200</u> <u>GRAY PART.</u> <u>STAIN</u> <u>26119-04</u>	<u>/</u> <u>T(F)B</u>	<u>7/23 1550</u>	<u>3.4608</u>	<u>3.2706</u>	<u>7/10 1715</u>	<u>0.1840</u>
Run				<u>7/24 1230</u>	<u>3.4603</u>			
Location					<u>3.4606</u>			
Type <u>FILTER</u>	<u>5</u>	<u>66 201</u> <u>FINE GRAY PART</u> <u>STAIN</u> <u>26119-05</u>	<u>/</u> <u>T(F)B</u>	<u>7/23 1600</u>	<u>3.7187</u>	<u>3.2721</u>	<u>7/10 1705</u>	<u>0.4436</u>
Run				<u>7/24 1240</u>	<u>3.7159</u>			
Location				<u>7/27 1105</u>	<u>3.7155</u>			
Type <u>FILTER</u>	<u>6</u>	<u>66 202</u> <u>FINE GRAY PART</u> <u>STAIN</u> <u>26119-06</u>	<u>/</u> <u>T(F)B</u>	<u>7/23 1600</u>	<u>3.6772</u>	<u>3.2548</u>	<u>7/10 1715</u>	<u>0.4198</u>
Run				<u>7/24 1240</u>	<u>3.6740</u>			
Location				<u>7/27 1100</u>	<u>3.6743</u>			
Type <u>FILTER</u>	<u>7</u>	<u>66 203</u> <u>LIGHT GRAY PART STAIN</u> <u>SPECIES OF FINE GR.</u> <u>26119-07</u>	<u>/</u> <u>T(F)B</u>	<u>7/23 1550</u>	<u>3.2921</u>	<u>3.2641</u>	<u>7/10 1715</u>	<u>0.0279</u>
Run				<u>7/24 1230</u>	<u>3.2916</u>			
Location					<u>3.2919</u>			
Type <u>FILTER</u>	<u>8</u>	<u>66 204</u> <u>FINE GRAY PART</u> <u>STAIN</u> <u>26119-08</u>	<u>/</u> <u>T(F)B</u>	<u>7/23 1550</u>	<u>3.3386</u>	<u>3.2549</u>	<u>7/10 1615</u>	<u>0.0835</u>
Run				<u>7/24 1245</u>	<u>3.3381</u>			
Location					<u>3.3384</u>			
Type <u>FILTER</u>	<u>9</u>	<u>66 205</u> <u>SPECIES OF FINE GR.</u> <u>PART.</u> <u>26119-09</u>	<u>/</u> <u>T(F)B</u>	<u>7/23 1550</u>	<u>3.2800</u>	<u>3.2790</u>	<u>7/10 1615</u>	<u>0.0010</u>
Run				<u>7/24 1245</u>	<u>3.2799</u>			
Location					<u>3.2800</u>			
Type <u>FILTER</u>	<u>10</u>	<u>66 206</u> <u>SPECIES OF FINE GR.</u> <u>PART.</u> <u>26119-10</u>	<u>/</u> <u>T(F)B</u>	<u>7/23 1550</u>	<u>3.3068</u>	<u>3.2976</u>	<u>7/10 1715</u>	<u>0.0072</u>
Run				<u>7/24 1215</u>	<u>3.3045</u>			
Location				<u>7/25 1110</u>	<u>3.3057</u>			
<u>vl@atim1</u>					<u>3.3048</u>			

Note appearance of particulate

Two volumes e.g. (500/100) indicate an aliquot was taken  
Indicate (T)himbler, (F)ilter, or (B)eaker in box below.

# Particulate Testing Weight Sheet

Page 2 of 3

Client <u>IER</u>	Project Number <u>1512-001</u>	Analyst <u>JLP</u>
Plant <u>NORSHIPCO</u>	Unit <u>---</u>	Balance <u>6A2000</u>
Test Date <u>7/14/92</u>		

Description	Wt. No.	I.D. and Sample Description	Sample volume (ml) <sup>2</sup>	Date/Time	Gross Weight (g)	Tare Weight (g)	Date/Time	Net Weight (g)
Type <u>FILTER</u>	1	<u>66 207</u> <u>LIGHT GRAY SMIN</u> <u>FINE BLK PMT.</u> <u>26119-11</u>	T F B	<u>7/23 1455</u>	<u>3.3659</u>	<u>3.2947</u>	<u>7/10 1710</u>	<u>0.0715</u>
Run				<u>7/24 1150</u>	<u>3.3664</u>			
Location					<u>3.3662</u>			
Type <u>FILTER</u>	2	<u>66 208</u> <u>HEAVY GRAY PMT.</u> <u>LOOSE FINE BLK PMT.</u> <u>26119-12</u>	T F B	<u>7/23 1520</u>	<u>3.5357</u>	<u>3.2857</u>	<u>7/10 1710</u>	<u>0.2497</u>
Run				<u>7/24 085</u>	<u>3.4938</u>			
Location				<u>7/27 1100</u>	<u>3.5334</u>			
Type <u>FILTER</u>	3	<u>66 209</u> <u>FINE BLK PMT.</u> <u>26119-13</u>	T F B	<u>7/23 1450</u>	<u>3.3185</u>	<u>3.2927</u>	<u>7/10 1715</u>	<u>0.0258</u>
Run				<u>7/24 1205</u>	<u>3.3174</u>			
Location				<u>7/27 1105</u>	<u>3.3179</u>			
Type <u>FILTER</u>	4	<u>66 210</u> <u>LIGHT GRAY PMT.</u> <u>SMIN</u> <u>26119-14</u>	T F B	<u>7/23 1550</u>	<u>3.3946</u>	<u>3.2820</u>	<u>7/10 1720</u>	<u>0.1126</u>
Run				<u>7/24 1200</u>	<u>3.3941</u>			
Location					<u>3.3940</u>			
Type <u>FILTER</u>	5	<u>66 211</u> <u>SPECKS OF BLK.</u> <u>PMNT.</u> <u>26119-15</u>	T F B	<u>7/23 1540</u>	<u>3.2953</u>	<u>3.2797</u>	<u>7/10 1725</u>	<u>0.0194</u>
Run				<u>7/24 1245</u>	<u>3.2988</u>			
Location					<u>3.2951</u>			
Type <u>FILTER</u>	6	<u>66 212</u> <u>FINE GRAY PMT.</u> <u>SMIN</u> <u>26119-16</u>	T F B	<u>7/23 1540</u>	<u>3.4489</u>	<u>3.2860</u>	<u>7/10 1730</u>	<u>0.1639</u>
Run				<u>7/24 1250</u>	<u>3.4485</u>			
Location					<u>3.4488</u>			
Type <u>FILTER</u>	7	<u>66 213</u> <u>LIGHT GRAY PMT.</u> <u>LOOSE GRAY PMT.</u> <u>26119-17</u>	T F B	<u>7/23 1570</u>	<u>3.5659</u>	<u>3.2904</u>	<u>7/10 1720</u>	<u>0.2858</u>
Run				<u>7/24 1245</u>	<u>3.5663</u>			
Location					<u>3.5662</u>			
Type <u>FILTER</u>	8	<u>66 214</u> <u>LIGHT GRAY PMT.</u> <u>HEAVY LOOSE BLK PMT.</u> <u>26119-18</u>	T F B	<u>7/23 1520</u>	<u>3.9381</u>	<u>3.2829</u>	<u>7/10 1710</u>	<u>0.6563</u>
Run				<u>7/24 1210</u>	<u>3.9394</u>			
Location				<u>7/27 1110</u>	<u>3.9389</u>			
Type <u>FILTER</u>	9	<u>66 215</u> <u>CLEAN</u> <u>26119-19</u>	T F B	<u>7/23 1605</u>	<u>3.2668</u>	<u>3.2669</u>	<u>7/10 1710</u>	<u>0.0001</u>
Run				<u>7/24 1140</u>	<u>3.2667</u>			
Location					<u>3.2668</u>			
Type <u>FILTER</u>	10	<u>66 216</u> <u>CLEAN</u> <u>26119-20</u>	T F B	<u>7/23 1605</u>	<u>3.2926</u>	<u>3.2932</u>		<u>0.0001</u>
Run				<u>7/24 1145</u>	<u>3.2929</u>			
Location					<u>3.2931</u>			

<sup>1</sup> Note appearance of particulate

<sup>2</sup> Two volumes (e.g. 500/100) indicate an aliquot was taken.  
Indicate (T)himbler, (F)ilter, or (B)eaker in box below.



# Particulate Testing Weight Sheet

Page 3 of 3

Client	T-113	Project Number	1512-GEN	Analyst	JLP
Plant	NORSHIPCO	unit		Balance	GA 2000
Test Date	7/14/92				

Description	Wt. No.	I.D. and Sample Description <sup>1</sup>	Sample volume (ml)	Date/Time	Gross Weight (g)	Tare Weight (g)	Date/Time	Net Weight (g)
Type FILTER	1	66 217 CLEAN	T F B	7/23/92	3.2879	3.2879	7/23/92	
Run				7/24/92	3.2879			
Location					3.2879			0.0000
Type FILTER	2	67 150 HEAVY FINE GRAY PART	T F B	7/23/92	4.6609	3.5143	7/10/92	
Run				7/24/92	4.6571			
Location				7/27/92	4.6566			1.1476
Type FILTER	3	67 149 HEAVY FINE GRAY PART	T F B	7/23/92	3.7878	3.5106	7/10/92	
Run				7/24/92	3.7873			
Location					3.7876			0.2770
Type FILTER	4	67 148 FINE PART. 50% T F B	T F B	7/23/92	3.8613	3.4975	7/10/92	
Run				7/24/92	3.8584			
Location				7/25/92	3.8590			0.3607
Type FILTER	5	67 147 HEAVY FINE GRAY PART	T F B	7/23/92	4.7435	3.4671	7/10/92	
Run				7/24/92	4.7438			
Location					4.7437			1.2766
Type FILTER	6	67 146 SPICES OF FINE BK PART T F B	T F B	7/23/92	3.4722	3.4682	7/10/92	
Run				7/24/92	3.4717			
Location					3.4717			0.0040
Type FILTER	7	67 145 HEAVY FINE GRAY PART FINE GRAY	T F B	7/23/92	4.6175	3.4669	7/10/92	
Run				7/24/92	4.6141			
Location				7/27/92	4.6138			0.2789
Type FILTER	8	67 144 HEAVY FINE GRAY PART FINE GRAY	T F B	7/23/92	3.7462	3.4671	7/10/92	
Run				7/24/92	3.7458			
Location					3.7458			0.2791
Type FILTER	9	66 123 LEADS 50% OF BK PART	T F B	7/23/92	3.4923	3.4817	7/10/92	
Run				7/24/92	3.4902			
Location				7/27/92	3.4900			0.0105
Type	10		T F B					
Run								
Location								

<sup>1</sup> Note appearance of particulate

<sup>2</sup> Two volumes (e.g. 500/100) indicate an aliquot was taken.  
Indicate (T)himbler, (F)ilter, or (B)eaker in box below.



**Please print. Instructions on reverse side correspond with circled numbers.**

# 15087

[illegible]

**A Division of Clean Air Engineering**  
**800-627-0033**

***Where Air Quality Analysis is Our Business***

# Request for Analysis

## Chain of Custody

**Please print. Instructions on reverse side correspond with circled numbers.**

# 15086

<b>1</b> Client: <u>TEA</u>		Project Name: <u>Norshipco</u>		Project Manager: <u>E. Poore</u>		Sampler: <u>P. Slater / B. Poore</u>	
Proj. #: <u>1512-001</u>		Location: <u>                    </u>		P.O.#: <u>PS1092</u>		Quote #: <u>                    </u>	

CAE Lab #	2 Sample Identification	Date	Time	3	4 Matrix	5 Analyses Requested	Remarks
	66-212	7/14/92					Retain filters for further analyses <div style="text-align: center;">↓</div>
	66-213	7/14/92					
	66-214	7/14/92					
	66-215	7/14/92					
	66-216	7/14/92					
	66-217	7/14/92					
	66-218	7/14/92					
	66-219	7/14/92					
	66-220	7/14/92					
	66-221						

<b>7</b> Turnaround time requested (check one only): <input checked="" type="checkbox"/> Normal 10-15 bus. days <input type="checkbox"/> 6-9 bus. days (1.5x list fee) <input type="checkbox"/> 3-5 bus. days (2x list fee) <input type="checkbox"/> 2 bus. days or less (3x list fee)		This form was completed by: <u>E. D. Poore</u> 7/17/92 Client Signature Date		<b>9</b> Analyzed by: <u>P. Slater</u> Date: <u>7/16</u> 17:35 Received by: <u>P. Chomare</u> Date: <u>7/17</u> 8:00	
--	--	--	--	---	--

<b>8</b> Rush results requested by (please circle): <u>Fax</u> or Phone Fax #: <u>919-460-1785</u> Phone #: <u>                    </u>		Bill to address: <u>                    </u>		<b>10</b> In case we have questions when samples arrive, CAE Analytical should call: Name: <u>E. Poore</u> Phone: <u>919-460-0852</u> Send report to: <u>E. Poore</u>	
--	--	--	--	---	--



**IEA**  
An Aquarion Company

148 Rangeway Road  
North Billerica, MA 01862

phone 617.272.5212  
Fax 5080667.7871

September 4, 1992

Everett Poore  
North Carolina Field Office  
120 South Center Court  
Suite 200  
Morrisville NC 27560

Client Ref: Norshipco  
IEA-MA Job #16853

Attn: Everett Poore

Dear Sir:

Please find enclosed results of analyses of sixteen filter and 5 bulk samples which you submitted. These samples were examined using SEM-EDX and PLM techniques to characterize airborne particulates from marine paint sandblasting operations.

METHODS:

portions of the three bulk paint chip samples were ground with a mortar and pestle. The fine particles from the two bulk blasting grit samples were separated by spreading the materials on a smooth plastic sheet. For SEM-EDX work, particles were supported on double-back tape and coated with evaporated graphite. For PLM, particles were immersed in oil of calibrated index of refraction ( $n=1.510$ ). For PLM work, particles were identified into four categories. The "Minerals" category included any birefringent angular to rounded, transparent, colorless to strongly colored particles. The "Opakes" category included all opaque (black) particles, plus any translucent particles also recognizable as paint or rust. The "Blast Grit" is transparent, isotropic, colorless to green-brown and always very angular, occasionally with inclusions and frequently showing conchoidal fracture. The "biological" are chiefly spores/ plus occasional pollens and vegetable fibers.

Monroe,  
Connecticut  
203.261.4458

Sunrise,  
Florida  
305.846.1730

Schaumburg,  
Illinois  
708.705.0740

Whippany,  
New Jersey  
201.428.8181

Research Triangle Park,  
North Carolina  
919.677.0090

Essex Junction,  
Vermont  
802.878.5138



**IEA**  
An Aquanon Company

Should you have further questions, or need additional information, please feel free to contact me at any time.

Sincerely,

Drew Killius  
Mgr. Microscopy Services

DK/ehs

IEA, INC.  
 Total Suspended Particulate Analysis by Polarized Light Microscopy  
 Version 4.2 (c) copyright 1989 by EAL, 1991 by IEA

CLIENT: NORSHIPCO

SAMPLE: 66-212

TSP (Ug/cubic meter) = 0)

ANALYZED BY: DK

08-27-1992

EAL JOB NO.: 16853

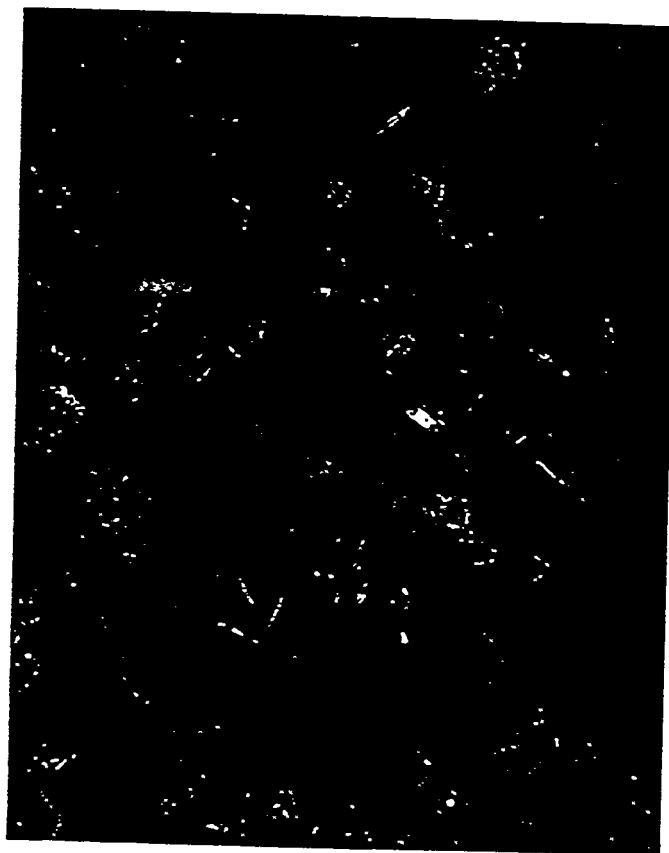
TYPE	WEIGHT %	NUMBER %	MEAN DIAM. (uM)	DENSITY
MINERALS	1	3	6	G= 2.6
OPAQUES	15	35	8	G= 1.5
BLAST GRIT	85	62	8	G= 2.6
BIOLOGICALS	0	0	0	G= 1.5

TOTAL COUNT: 100

PHOTO A: 500X, PARTLY X-POLARS, TYPICAL

PHOTO H: 500X, PARTLY X-POLARS, TYPICAL

\*\*-B-\*\*-







#### FINDINGS:

Looking first at the bulk materials, the paint chips and blasting grit are readily distinguishable, both by PLM and EDX. The blasting grit appears to be a glass product, having characteristic optical properties, and particle morphology (see "methods" above). Chemically, it shows major amounts of aluminum, silicon, and iron, with smaller amounts of potassium and calcium. Spectra of both samples are virtually identical. The fine particles shown in the PLM micrograph of sample 17 (ACO) are a good representation of how the material appears in the PLM photos of the filter samples. The paints appear optically as opaque material of irregular to somewhat rounded outline, and as such, resemble many common soots. Occasional translucent particles are also present, including material recognizable as rust. Chemically we see two or three classes of material. The Freeboard sample shows high titanium, plus zinc, while the other two samples (boot-top, keel-bilge) show major copper, plus zinc, and a variable amount of iron. The elements copper, zinc, and titanium are unique to the paints and can be used as good tracers for airborne paint dust. Since iron is geochemically common, and occurs both as rust and as a constituent in the blasting grit, its usefulness as a chemical marker is somewhat more limited.

Turning to the filters, we can look first at the blank (66-217), where we see that the glass is a calcium-rich type and very inconspicuous in the PLM photo. The technique we use to remove particles from the filters is effective, and in the PLM work the glass fibers are also readily recognizable and do not constitute an interference.

After the blank, sample 66-127 appears to be the natural background in the area. Minerals, soots, and biological are present and typical in amount and appearance. Note in the EDX spectrogram the presence of a distinct peak for sulfur. This is a good indication that the soots are from combustion of high-sulfur fuels. The sulfur is also a good marker to help distinguish the soot fraction in the "opaques" category in the PLM analyses. The size of the particles shown in the photos is also typical of PM-10 type collection. (Note: at 500X, the scale is 1mm=2um; e.g. a 10 micron particle will measure 5 millimeters). One filter (66-214) was apparently not a pm-10 type, and the very coarse particles present are readily apparent in the photos. Among the other samples given a full PLM analysis only one of the filters (66-210) showed mean sizes for the grit and opaques above the 10 UM level. It should be noted however that many filters showed mean sizes very close to the 10 micron level. Three filters were indicated as being of interest with regard to size only. I have done an abbreviated "one-category" PLM analysis on samples 66-203, 66-202, and 67-144 in order to obtain mean size information comparable to the mean size data given for the other (4-category) PLM analyses.



The last analyses conducted were particle size by sieving on the two bulk blasting grit samples. The table below gives weight percent in each size range:

	ACO	Norshipco
+ 1mm	46.9	86.1
- 1 + 0.5mm	25.8	11.2
-0.5 + 60 mesh	8.3	~ 1.6
-60 + 140	11.3	0.9
-140 + 300	6.1	~ 0.2
- 300	1.6	0.1

#### DISCUSSION:

The overall picture which emerges here is that the fines from the blasting grit appear to be having the major impact on air quality. In the PLM analyses, the photos give a good qualitative appraisal. In using the weight percent data, keep in mind that the method may have one or two systematic biases. Firstly, particles are viewed lying flat on a microscope slide. Thin flakes or flattened chips may have a preferred orientation which presents their largest dimension, causing an overestimate of mass. Secondly, the mass calculation is based on a density value obtained from published data, which may not be exactly correct for the specific materials involved here. The number percent data, however, is less affected by preferred orientation. Likewise, the EDX data is obtained from a much larger population of more randomly oriented particles. None of the EDX analyses on the air filters show more than a few percent of copper, zinc, or titanium. This is also good evidence that the paint dust is not becoming airborne in large amounts. What does show in the EDX data is a variable amount of iron, which suggests that metal and rust particles may be more abundant than paint dust. This also agrees with the nature of the bulk paint samples; they are in the form of large flakes and chips. What I suspect is happening is that the greatest bulk of the paint is being removed by scraping or chipping, and that the sandblasting is being used to remove only the last vestiges of paint along with any rust, and even some fresh metal, as the final surface preparation step prio: to applying to the new finish.

IEA, INC.  
 Total Suspended Particulate Analysis by Polarized Light Microscopy  
 version 4.2 (c) Copyright 1989 by EAL, 1991 by IEA

CLIENT: NORSHIPCO

SAMPLE: 67-148

TSP (ug/cubic meter) = 0

ANALYZED BY: DK

09-01-1992

EAL JOB NO.:

TYPE	WEIGHT %	NUMBER %	MEAN DIAM.(uM)	DENSITY
MINERALS	1	3	8	G= 2.6
OPAQUES	5	25	7	G= 1.5
BLAST GRIT	93	70	10	G= 2.6
BIOLOGICALS	<1	2	6	G= 1.5

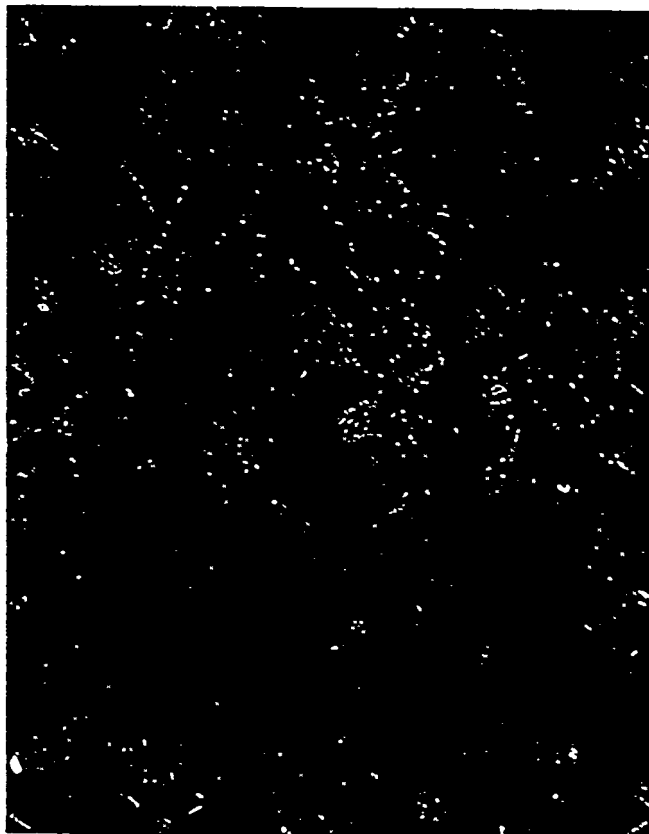
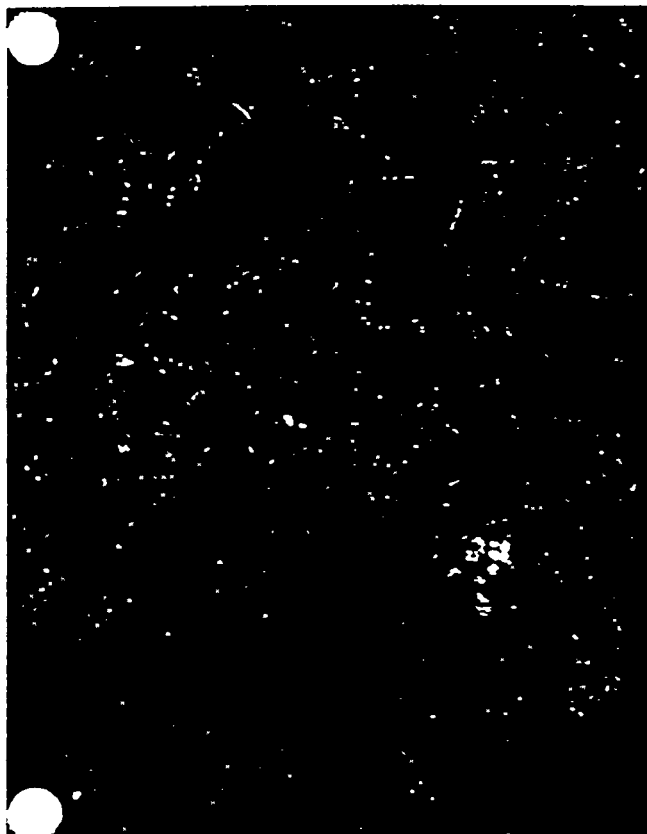
TOTAL COUNT: 100

PHOTO A: 500X, PARTLY X-POLARS, TYPICAL

PHOTO B: 500X, PARTLY X-POLARS, TYPICAL

**\*\*-A-\*\*-**

**\*\*-B-\*\*-**



IEA, INC.  
 Total Suspended Particulate Analysis by Polarized Light Microscopy  
 -sion 4.2 (c) Copyright 1989 by EAL, 1991 by IEA

CLIENT: NORSHIPCO

SAMPLE: 67-149

TSF (ug/cubic meter) = 0

ANALYZED BY: DK

09-01-1992

EAL JOB NO.:

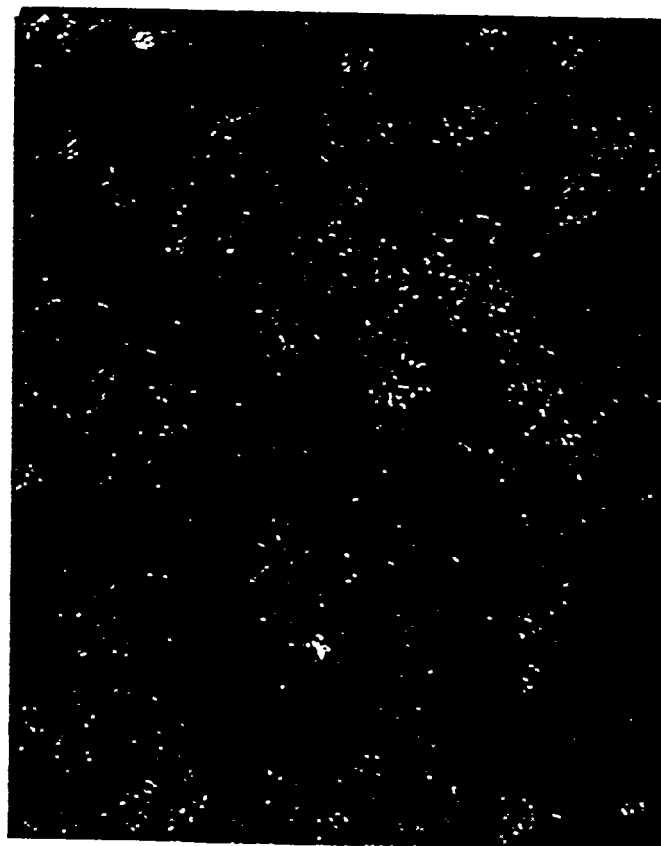
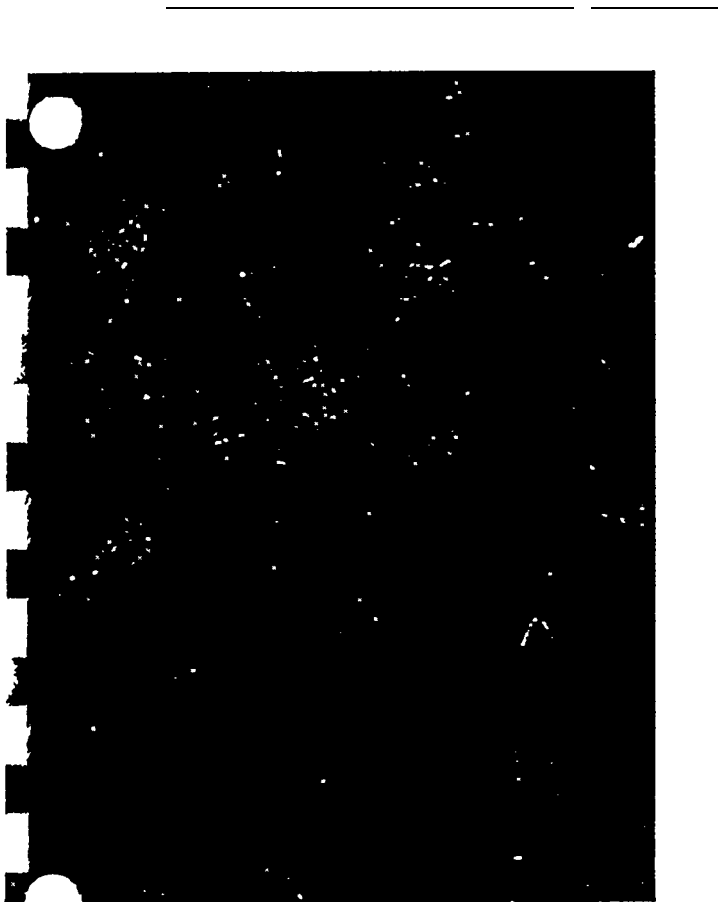
TYPE	WEIGHT %	NUMBER %	MEAN DIAM.CUM)	DENSITY
MINERALS	0	0	0	G= 2.6
OPAQUES	12	32	8	G= 1.5
BLAST GRIT	87	67	10	G= 2.6
BIOLOGICALS	1	1	10	G= 1.5

TOTAL COUNT: C1100

PHOTO A: 500X, PARTLY X-POLARS, TYPICAL  
 PHOTO H: 500X, PARTLY X-POLARS, TYPICAL

\*\*A-\*\*

\*\*B-\*\*



IEA, INC.  
 TOtal Suspended Particulate Analysis by Polarized Light Microscopy  
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CLIENT: NORSHIPCO

SAMPLE: 66-200

TSP (ug/cubic meter) = 0

ANALYZED BY: DK

08-27-1992

EAL JOB NO.: 16853

TYPE	WEIGHT %	NUMBER %	MEAN DIAM.CUM>	DENSITY
MINERALS	2	2	9	G= 2.6
OPAQUES	11	36	7	G= 1.5
BLAST GRIT	86	61	9	G= 2.6
BIOLOGICALS	2	1	1.5	G= 1.5

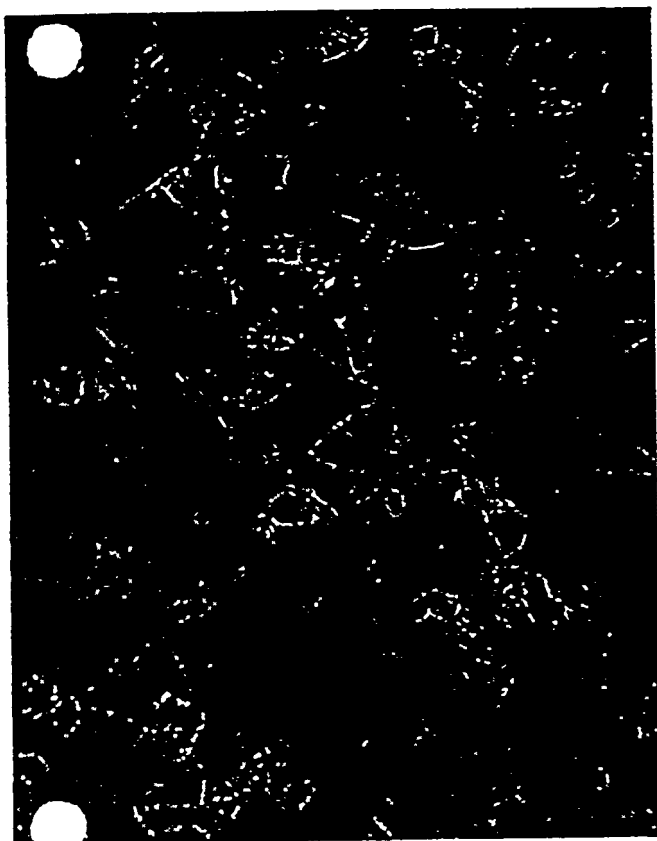
TOTAL COUNT: 100

PHOTO A: 500X, PARTLY X-POLARS, TYPICAL

PHOTO H: 500X, PARTLY X-POLARS, TYPICAL

\*\*A\*\*

\*\*B\*\*



IEA, INC.  
 Total Suspended particulate Analysis by Polarized Light Microscopy  
 rsion, 4.2 (c) Copyright 1989 by EAL, 1991 by IEA

CLIENT: NORSHIPCO

SAMPLE: 66-127 TSP (ug/cubic meter) = (0)

ANALYZED BY: DK 09-01-1992 EAL JOB NO.:

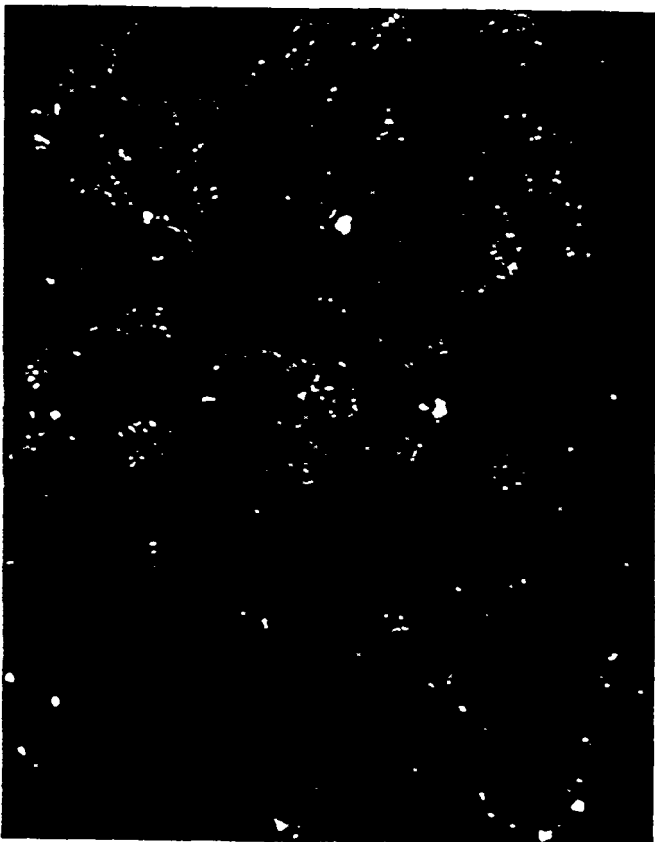
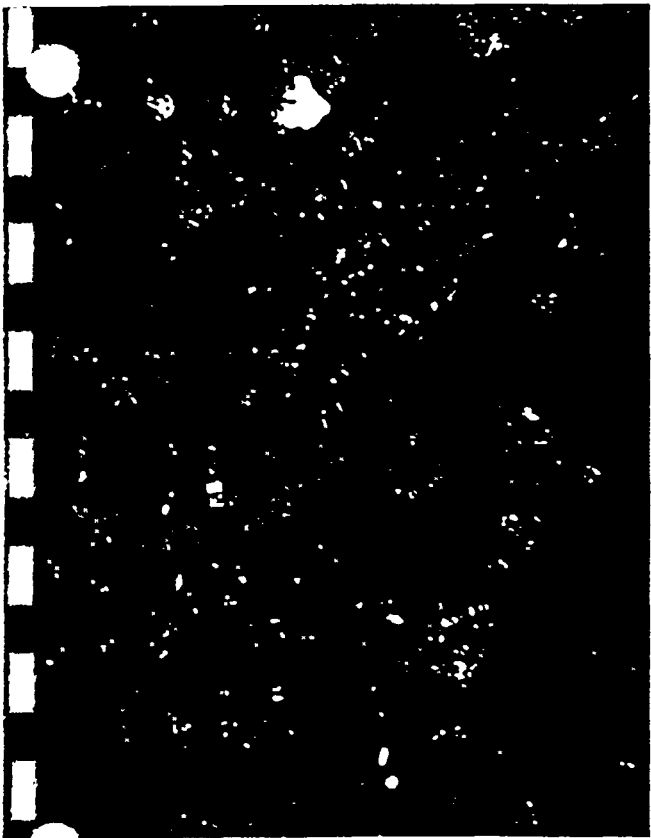
TYPE	WEIGHT %	NUMBER %	MEAN DIAM.(uM)	DENSITY
MINERALS	36	44	7	G= 2.6
OPAQUES	21	29	7	G= 1.5
ELAST GRIT	8	6	8	G= 2.6
BIOLOGICALS	36	21	8	G= 1.5

TOTAL COUNT: 100

PHOTO A: 500X, PARTLY X-POLARS, TYPICAL  
 PHOTO B: 500X, PARTLY X-POLARS, TYPICAL

\*\*\_A\_\*\*

\*\*\_B\_\*\*



IEA, INC.  
Total Suspended Particulate Analysis by Polarized Light Microscopy  
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CLIENT: NORSHIPCO

SAMPLE: 66-207

TSP (ug/cubic meter) = 0

ANALYZED BY: DK

08-27-1992

EAL JOB NO.: 16853

TYPE	WEIGHT %	NUMBER %	MEAN DIAM.(uM>	DENSITY
MINERALS	11	8	9	G= 2.6
OPAQUES	27	49	8	G= 1.5
BLAST GRIT	58	40	10	G= 2.6
BIOLOGICALS	4	3	10	G= 1.5

TOTAL COUNT: 100

PHOTO A: 500X, PARTLY X-POLARS, TYPICAL  
PHOTO B: 500X, PARTLY X-POLARS, TYPICAL

\*\*\_A\_\*\*

\*\*\_B\_\*\*



IEA, INC.  
Total Suspended Particulate Analysis by Polarized Light Microscopy  
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CLIENT: NORSHIPCO

SAMPLE: 66-210 TSp (ug/cubic meter:) = 0

ANALYZED BY: DK 09-01-1992 EAL JOB NO.:

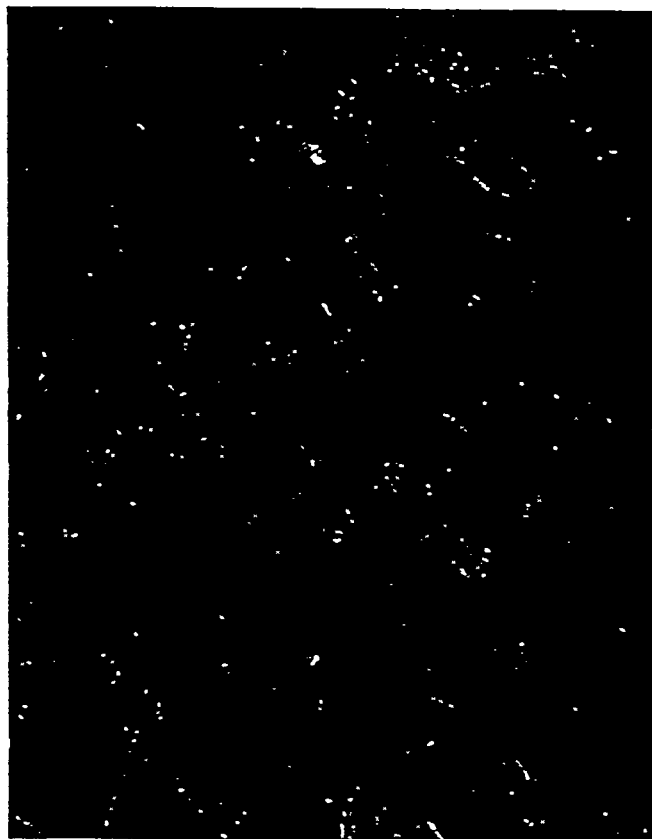
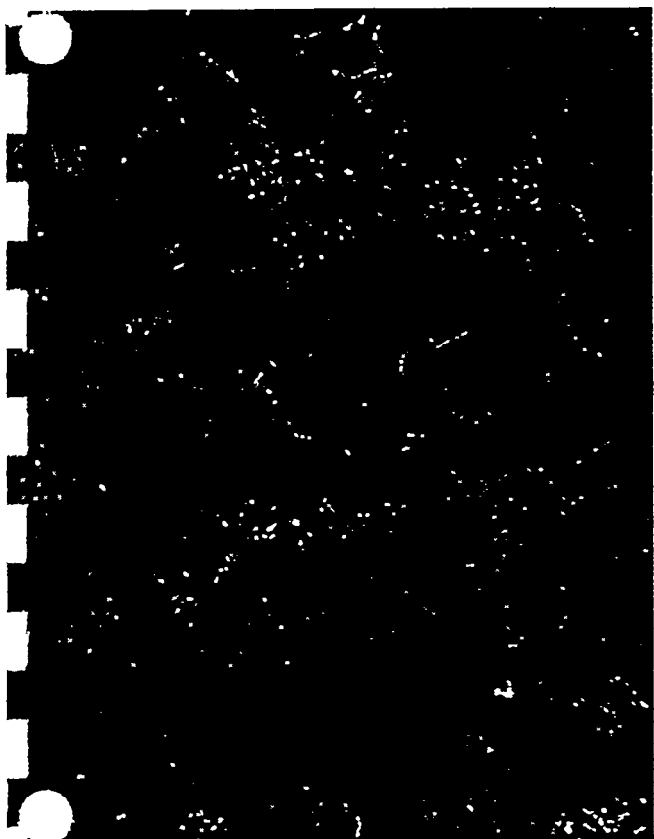
TYPE	WEIGHT %	NUMBER %	MEAN DIAM.(uM)	DENSITY
MINERALS	4	4	14	G= 2.6
OPAQUES	24	39	12	G= 1.5
BLAST GRIT	72	57	13	G= 2.6
BIOLOGICAL	0	0	0	G= 1.5

TOTAL COUNT: 100

PHOTO A: 500X, PARTLY X-POLARS, TYPICAL

PHOTO B: 500X, PARTLY X-POLARS, TYPICAL

\*\*\_B\_\*\*





IEA, INC.  
 Total Suspended Particulate Analysis by Polarized Light Microscopy  
 version 4.2 (CI) Copyright 1989 by EAL, 1991 by IEA

CLIENT: NORSHIPCO

SAMPLE: 56-208

TSP (ug/cubic meter) = 0

ANALYZED BY: DK

08-27-1992

EAL JOB NO.: 16853

TYPE	WEIGHT %	NUMBER %	MEAN DIAM.(uM	DENSITY
MINERALS	<1	5	9	G= 2.6
OPAQUES	10	17	15	G= 1.5
BLAST GRIT	89	78	18	G= 2.6
BIOLOGICALS	0	0	0	G= 1.5

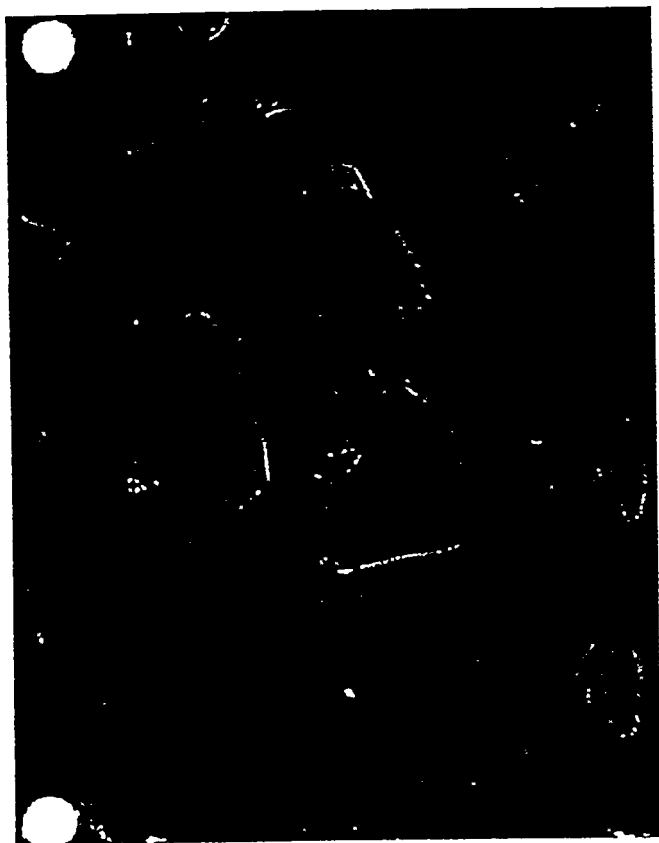
TOTAL COUNT: 100

PHOTO A: 500X, PARTLY X-POLARS, TYPICAL

PHOTO B: 500X, PARTLY X-POLARS, TYPICAL

\*\*\_A-\*\*

\*\*\_B-\*\*



I



IEA, INC.

Total Suspended Particulate Analysis by Polarized Light Microscopy  
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CLIENT: NORSHIPCO

SAMPLE: 66-199

TSP (ug/cubic meter:) = 0

ANALYZED BY: DK

09-01-1992

EAL JOB NO.:

TYPE	WEIGHT %	NUMBER %	MEAN DIAM. (uM)	DENSITY
MINERALS	<1	3	11	G= 2.6
OPAQUES	7	37	12	G= 1.5
BLAST GRIT	91	59	17	G= 2.6
BIOLOGICALS	1	1	25	G= 1.5

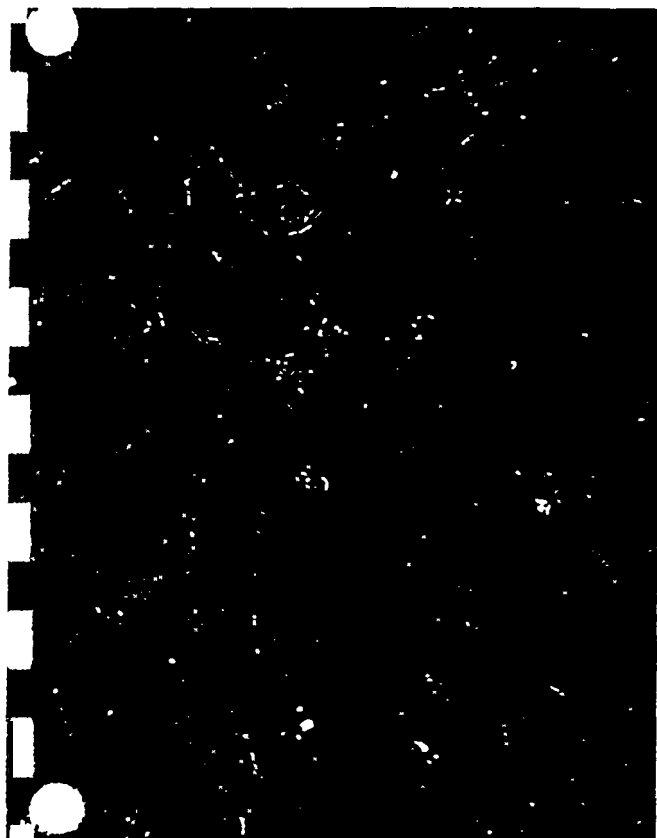
TOTAL COUNT: 100

PHOTO A: 500X, PARTLY X-POLARS, TYPICAL

PHOTO B: 500X, PARTLY X-POLARS, TYPICAL

\*\*\_A\_\*\*

\*\*\_B\_\*\*



IEA, INC.  
 Total Suspended Particulate Analysis by Polarized Light Microscopy  
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CLIENT: NORSHIPCO

SAMPLE: 67-150

TSP (ug/cubic meter:) = 0

ANALYZED BY: DK

09-01-1992

EAL JOB NO.:

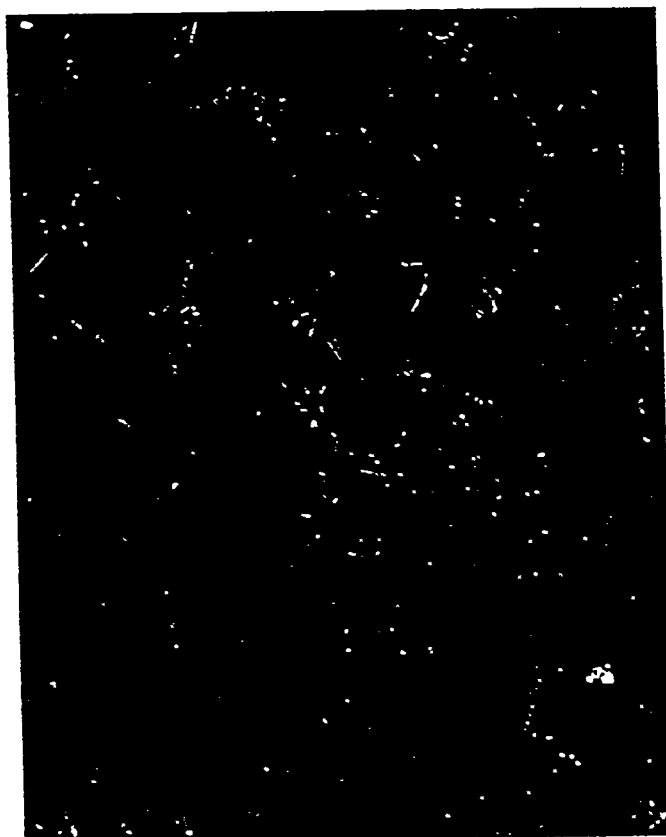
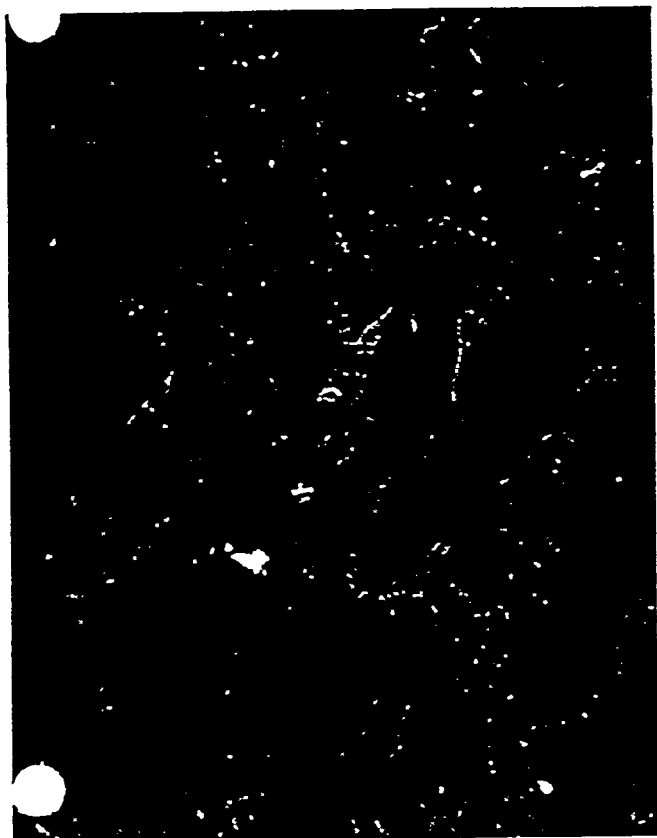
TYPE	WEIGHT %	NUMBER %	MEAN DIAM. (uM)	DENSITY
MINERALS	<1	3	10	G= 2.6
OPAQUES	27	46	15	G= 1.5
BLAST GRIT	72	51	18	G= 2.6
BIOLOGICALS	0	0	0	G= 1.5

TOTAL COUNT: 100

PHOTO A: 500X, PARTLY X-POLARS, TYPICAL  
 PHOTO B: 500X, PARTLY X-POLARS, TYPICAL

\*\* -A- \*\*

\*\* -B- \*\*



IEA, INC.  
 Total Suspended Particulate Analysis by Polarized Light Microscopy  
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CLIENT: NORSHIPCO

SAMPLE: 66-213 TSP (ug/cubic meter) = 0

ANALYZED BY: DK 09-01-1992 EAL JOB NO.:

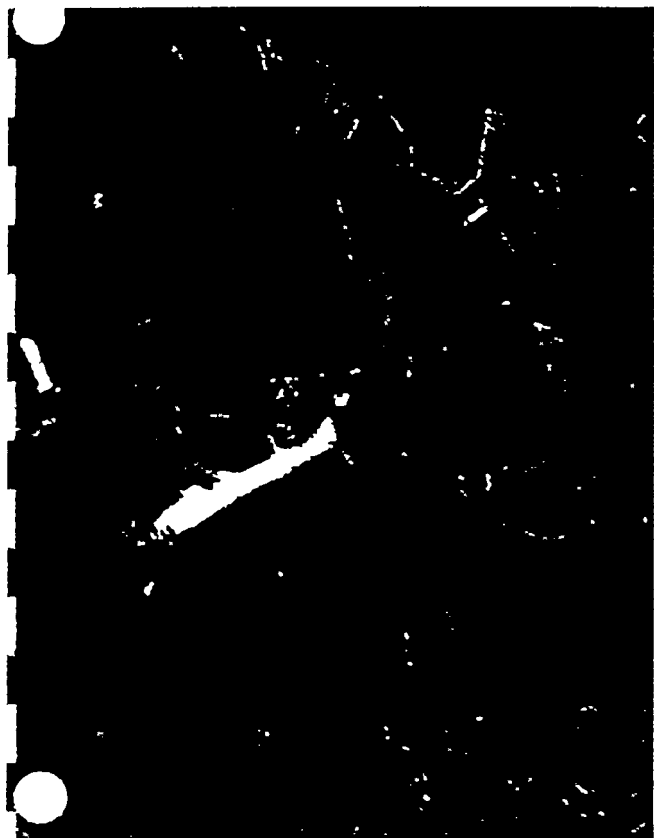
TYPE	WEIGHT %	NUMBER %	MEAN DIAM. (um)	DENSITY
MINERALS	1	2	19	G= 2.6
OPAQUES	5	18	16	G= 1.5
BLAST GRIT	90	78	20	G= 2.6
BIOLOGICALS	3	2	33	G= 1.5

TOTAL COUNT: 100

PHOTO A: 500X, PARTLY X-POLARS, TYPICAL  
 PHOTO B: 500X, PARTLY X-POLARS, TYPICAL

\*\*A\*\*

\*\*B\*\*



IEA, INC.  
 Total Suspended Particulate Analysis by Polarized Light Microscopy  
 version 4.2 (c) Copyright 1989 by EAL~ 1991 by IEA

CLIENT: NORSHIPCO

SAMPLE: 66-214 TSP (ug/cubic meter = 0

ANALYZED BY: DK 08-27-1992 EAL JOB NO.: 16853

TYPE	WEIGHT %	NUMBER %	MEAN DIAM-(uM)	DENSITY
MINERALS	<1	1	20	G= 2.6
OPAQUES	13	22	53	G= 1.5
BLAST GRIT	87	77	60	G= 2.6
BIOLOGICALS	0	0	0	G= 1.5

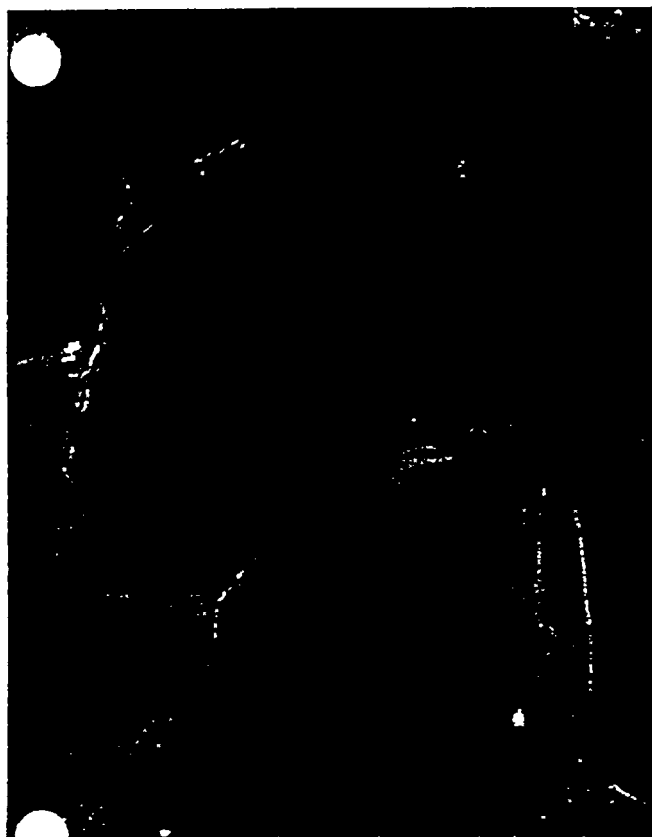
TOTAL COUNT: 100

PHOTO A: 500X, PARTLY X-POLARS, TYPICAL

PHOTO B: 500X, PARTLY X-POLARS, TYPICAL

\*\*\_A-\*\*

\*\*\_B-\*\*



IEA, INC.  
Total Suspended Particulate Analysis by Polarized Light Microscopy  
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CLIENT: NORSHIPCO

SAMPLE: 66-203 TSP (ug/cubic meter) = 0

ANALYZED BY: DK 09-02-1992 EAL JOB NO.:

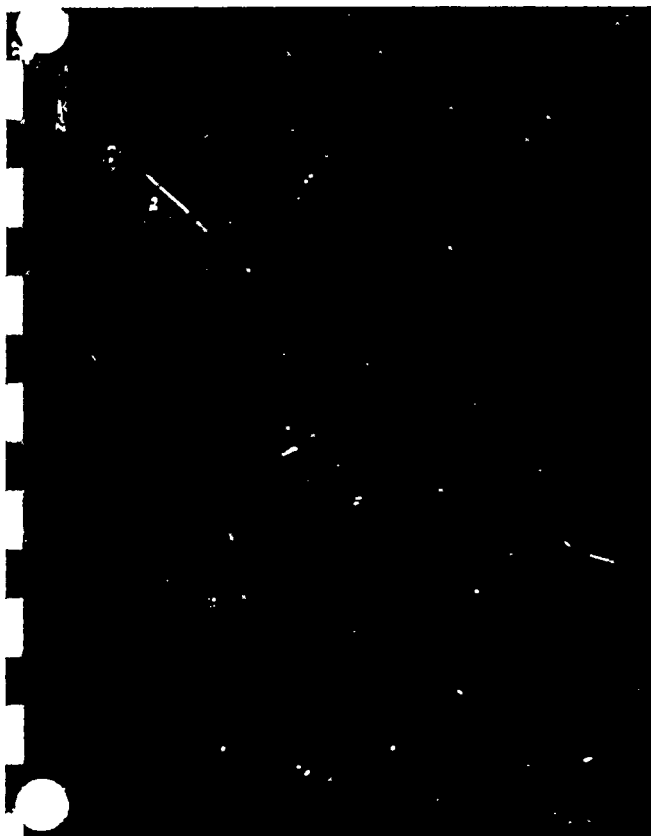
TYPE	WEIGHT %	NUMBER %	MEAN DIAM. (uM)	DENSITY
AVER.PART.	100	100		G= 2

TOTAL COUNT: 50

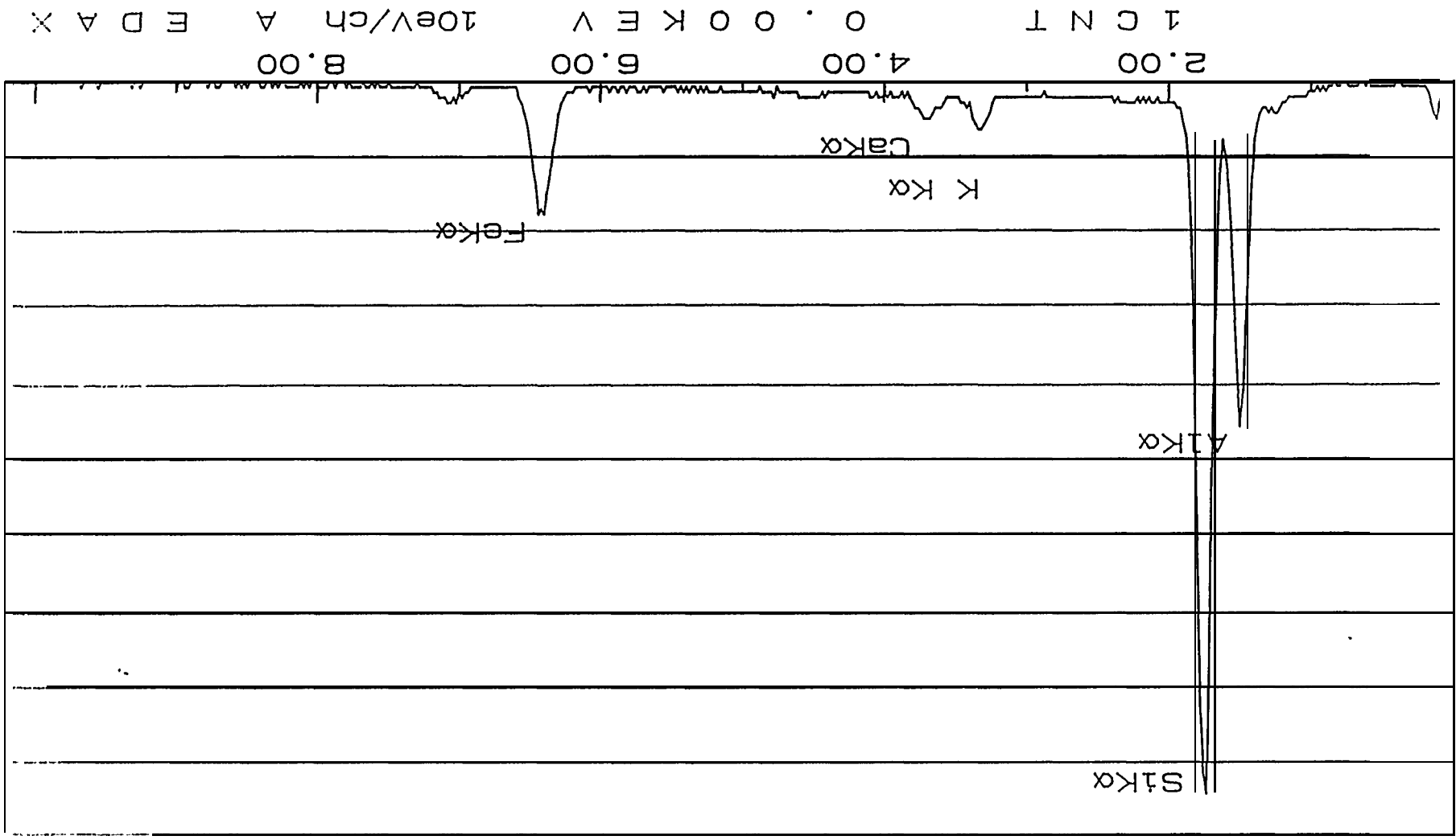
PHOTO A: 500X, PARTLY X-POLARS, TYPICAL  
PHOTO B: 500X, PARTLY X-POLARS, TYPICAL

\*\*\_A\_\*\*

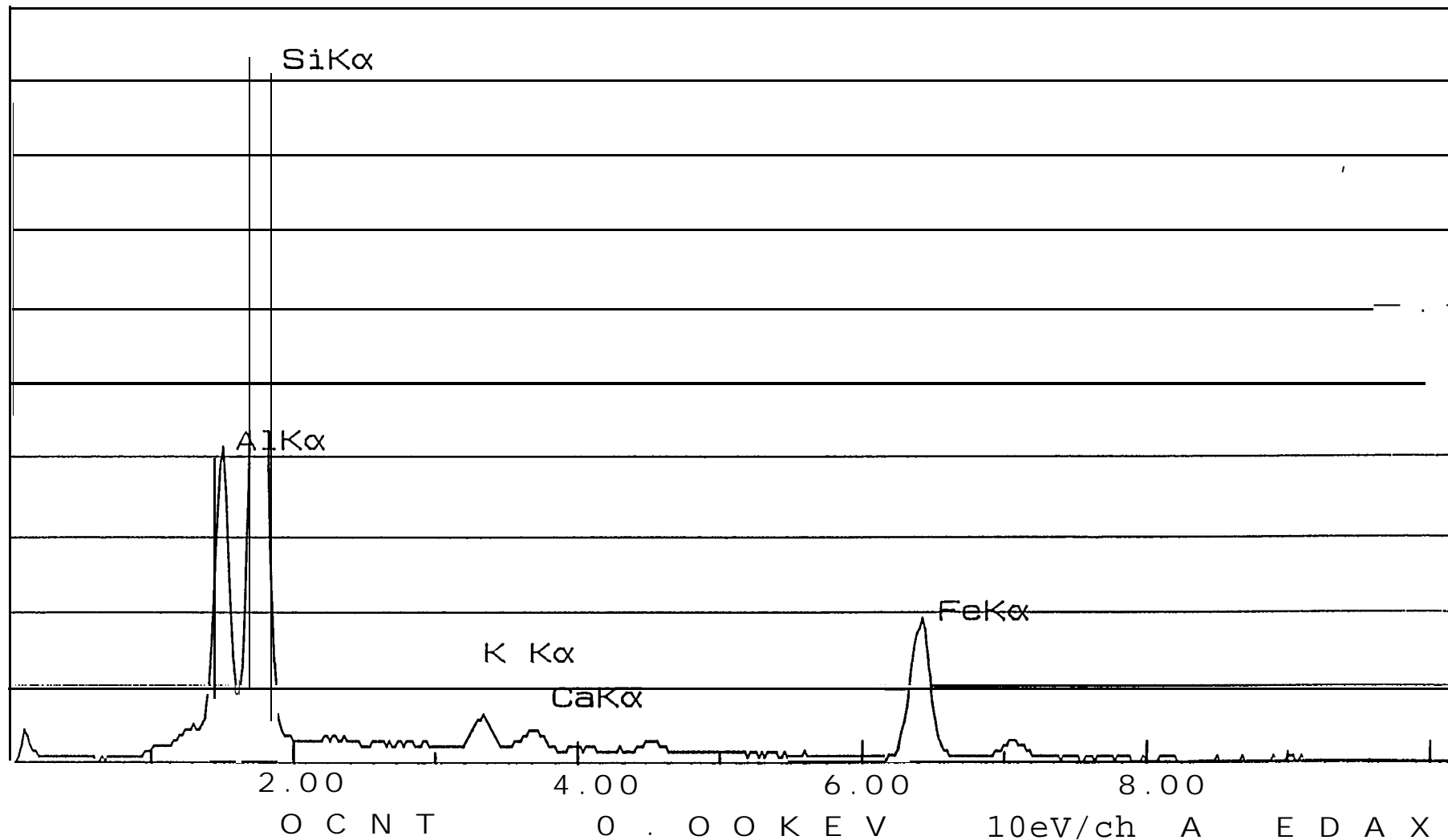
\*\*\_B\_\*\*



21 - AUG - 92 15: 17: 33 EDA X R E A D Y  
 RATE = 4 CPS TIME = 148 L SEC  
 FS = 4598 CNT PRST = 200 L SEC  
 A = S A N D B L A S T M A T " L N O R S H I P C O

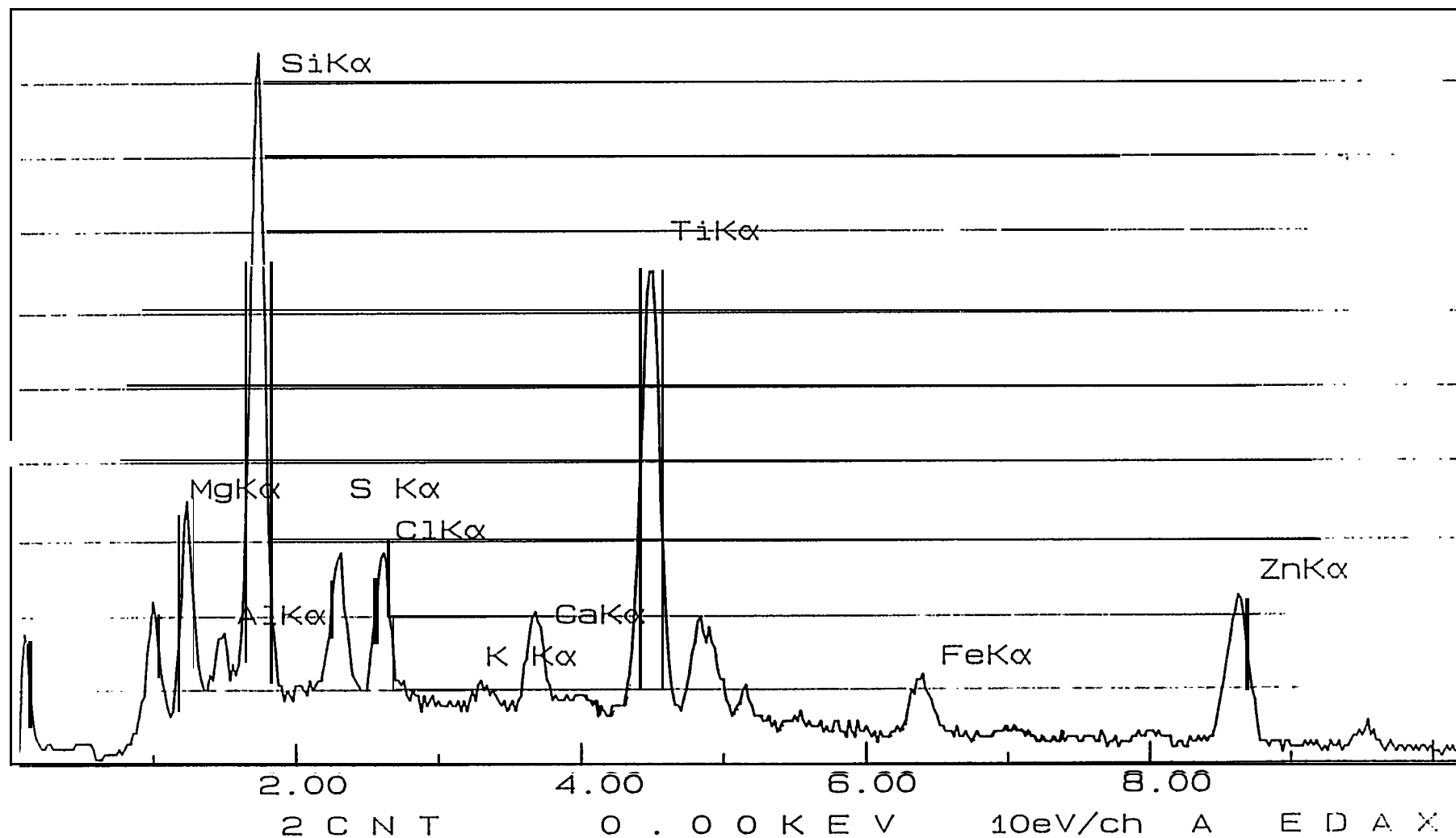


21, - AUG - 92 15:27:43 EDAX READY  
RATE = O C P S TIME = 150 LSEC  
FS = 10457 CNT PRST = 150 LSEC  
A = SANDBLAST MAT'L ACO

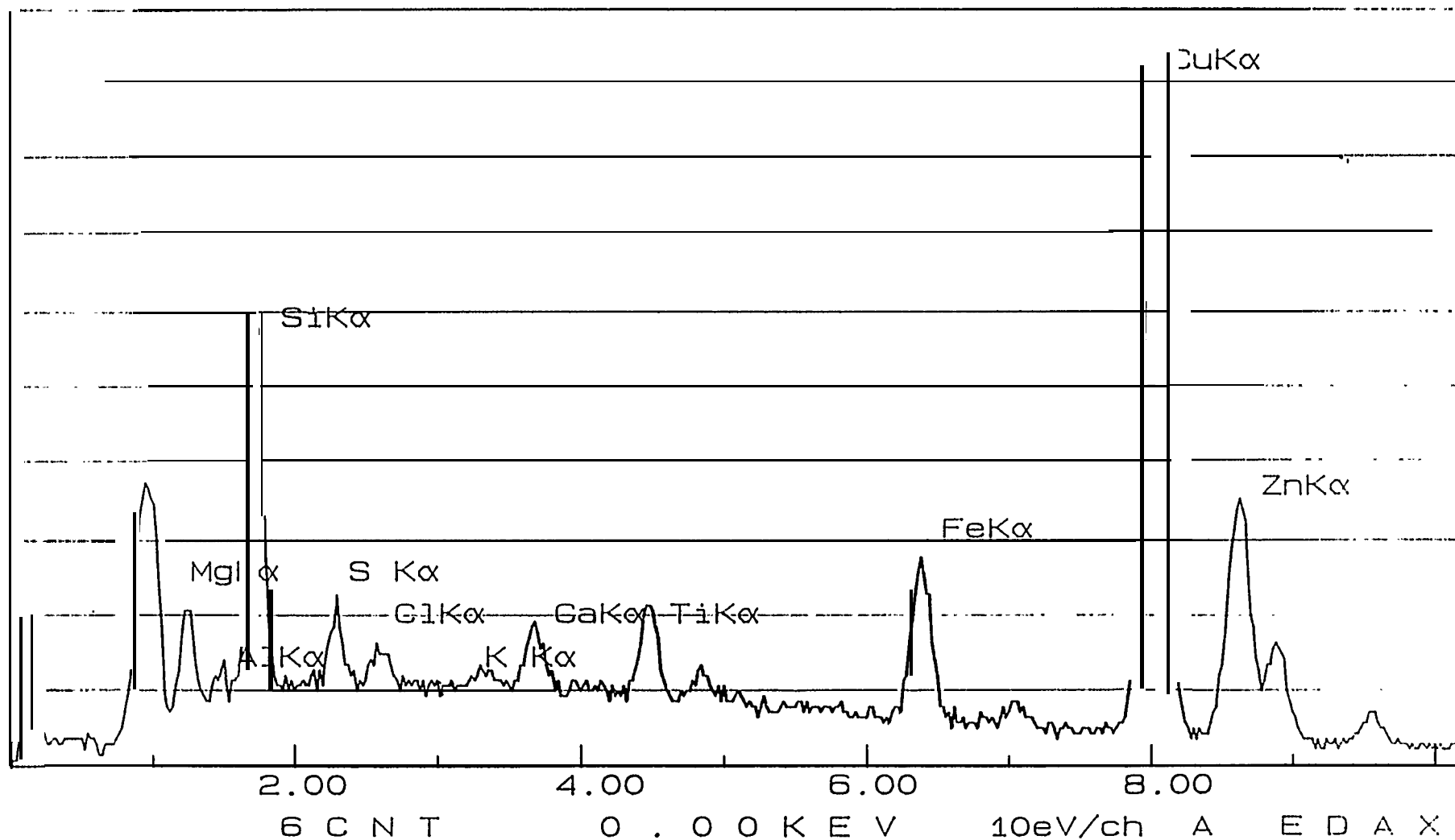




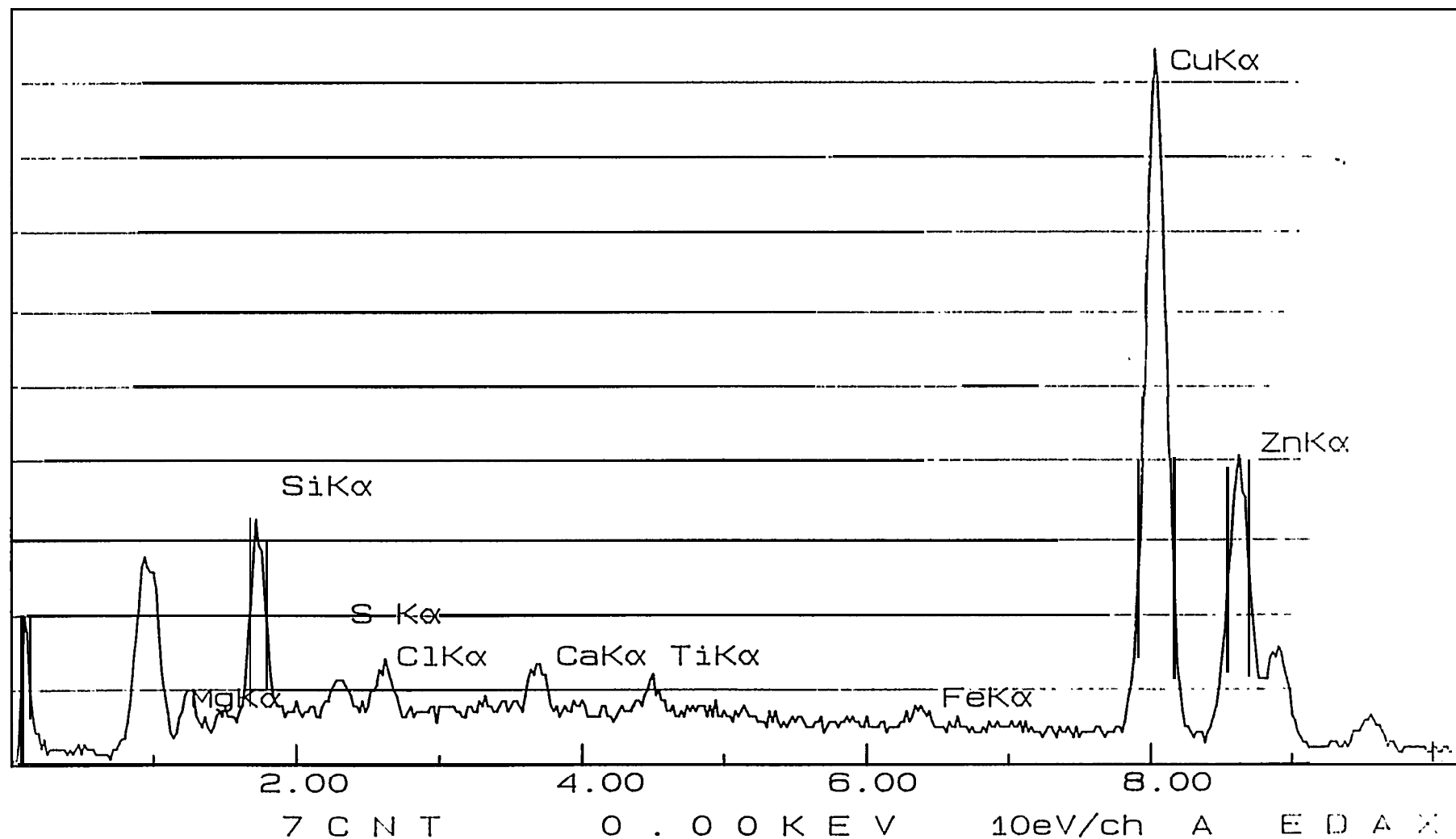
27 - AUG - 92 13:46:02 EDAX READY  
RATE = 6 CPS TIME = 150 LSEC  
FS = 1867 CNT PRST = 150 LSEC  
A = USNS FREE BOARD



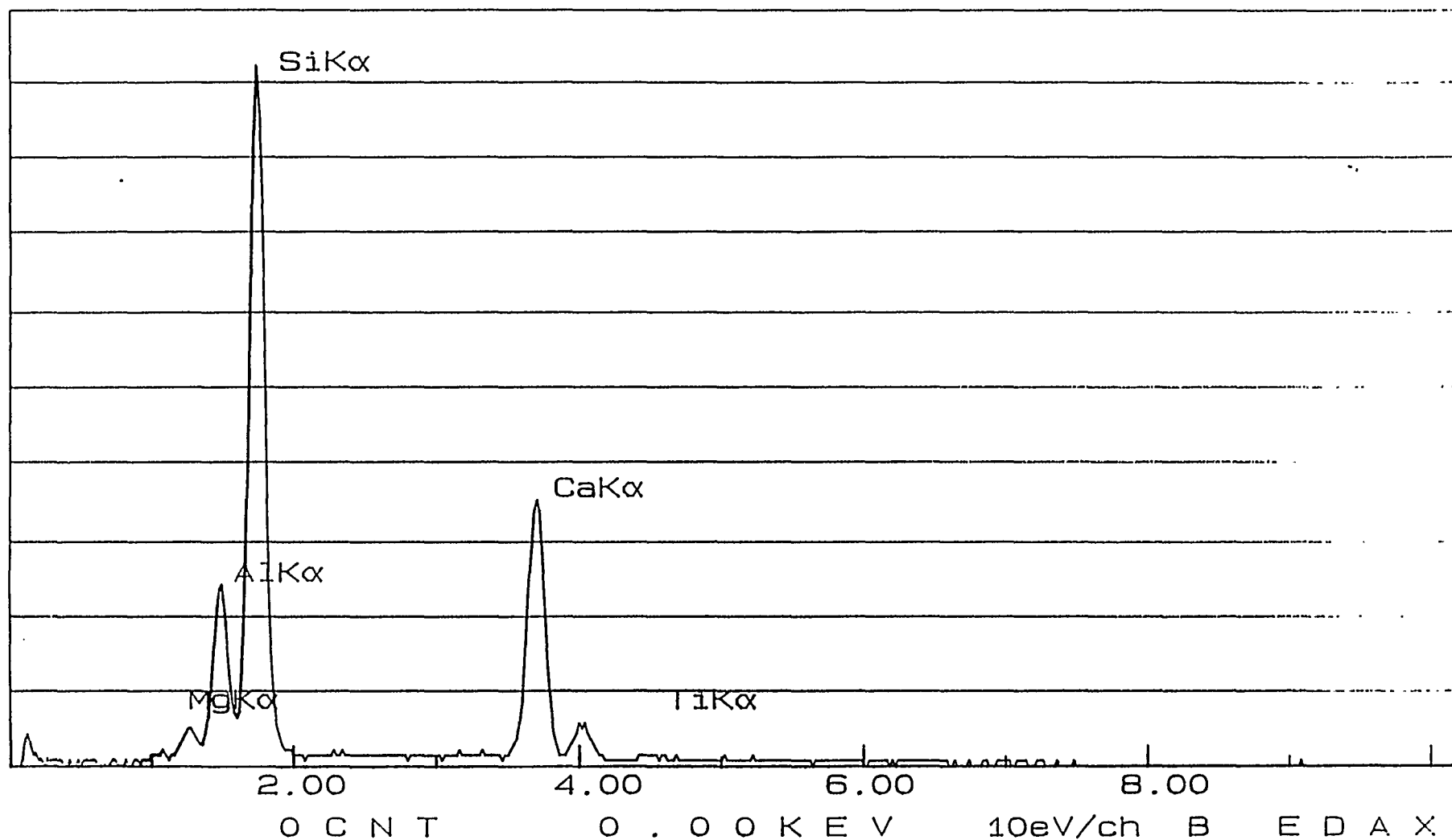
27 - AUG - 92 13:54:28 EDAX READY  
RATE = 4 CPS TIME = 150 LSEC  
FS = 1963 CNT PRST = 150 LSEC  
A = USNS KEEL TO TURN OF BILGE



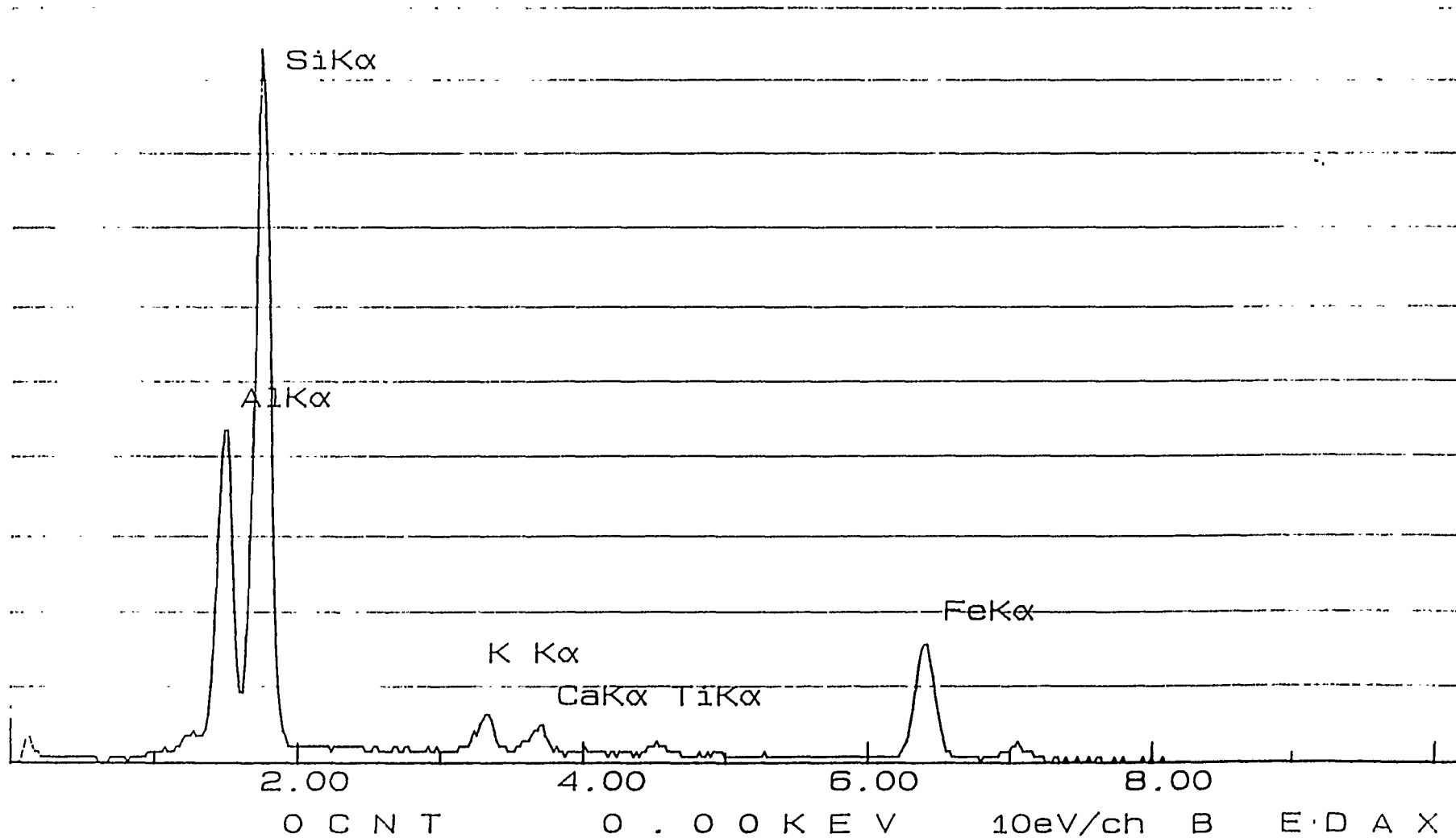
27 - AUG - 92 13:33:57 EDAX READY  
RATE = 21 CPS TIME = 150 L SEC  
FS = 1880 CNT PRST = 150 L SEC  
A = USNS LT. LOAD TO DEEP BOOTOP



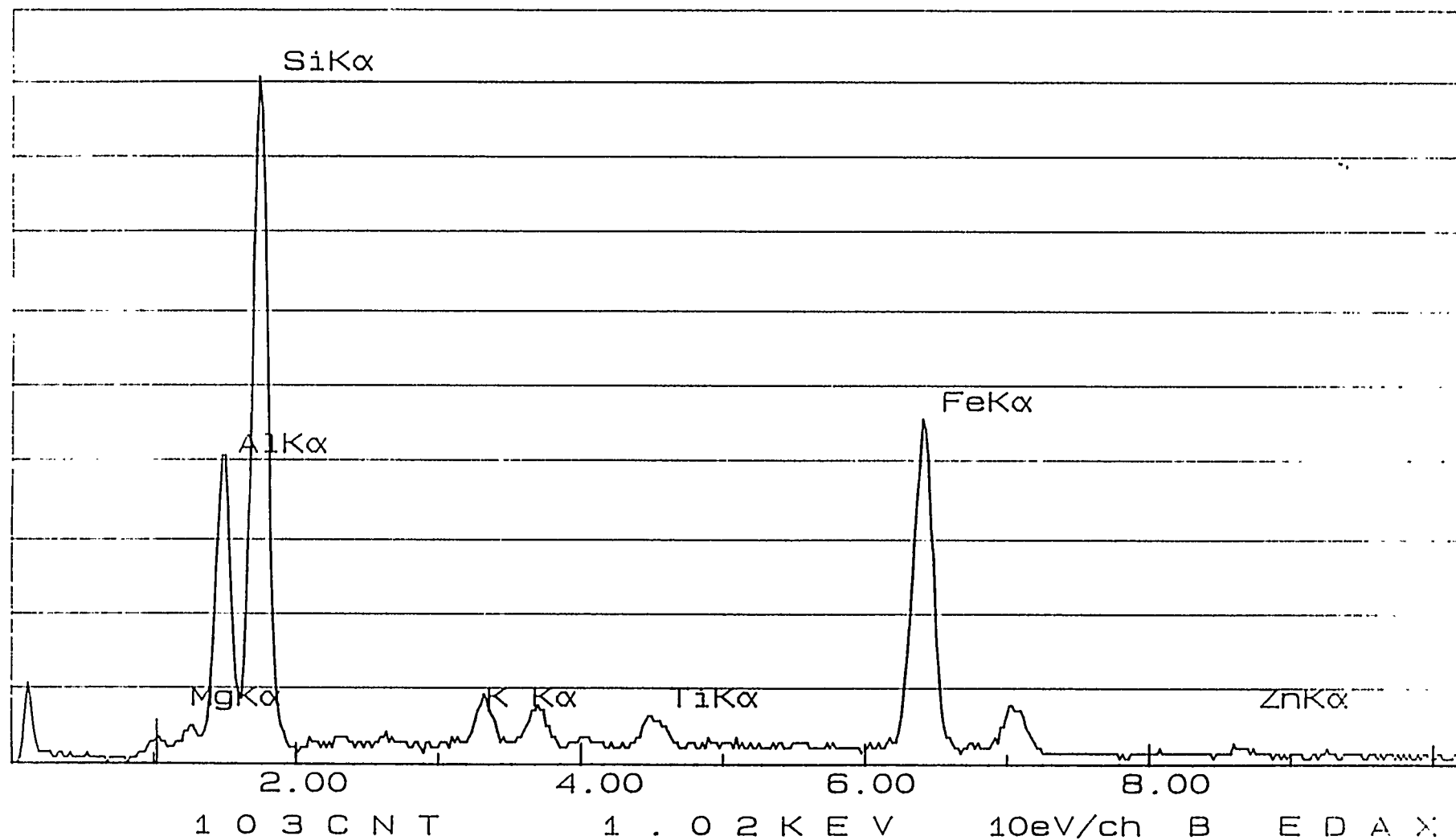
26 - AUG - 92 11:48:22 EDAX READY  
RATE = 0 CPS TIME = 123 L SEC  
FS = 4965 CNT PRST = 150 L SEC  
B = 66 - 217 FILTER



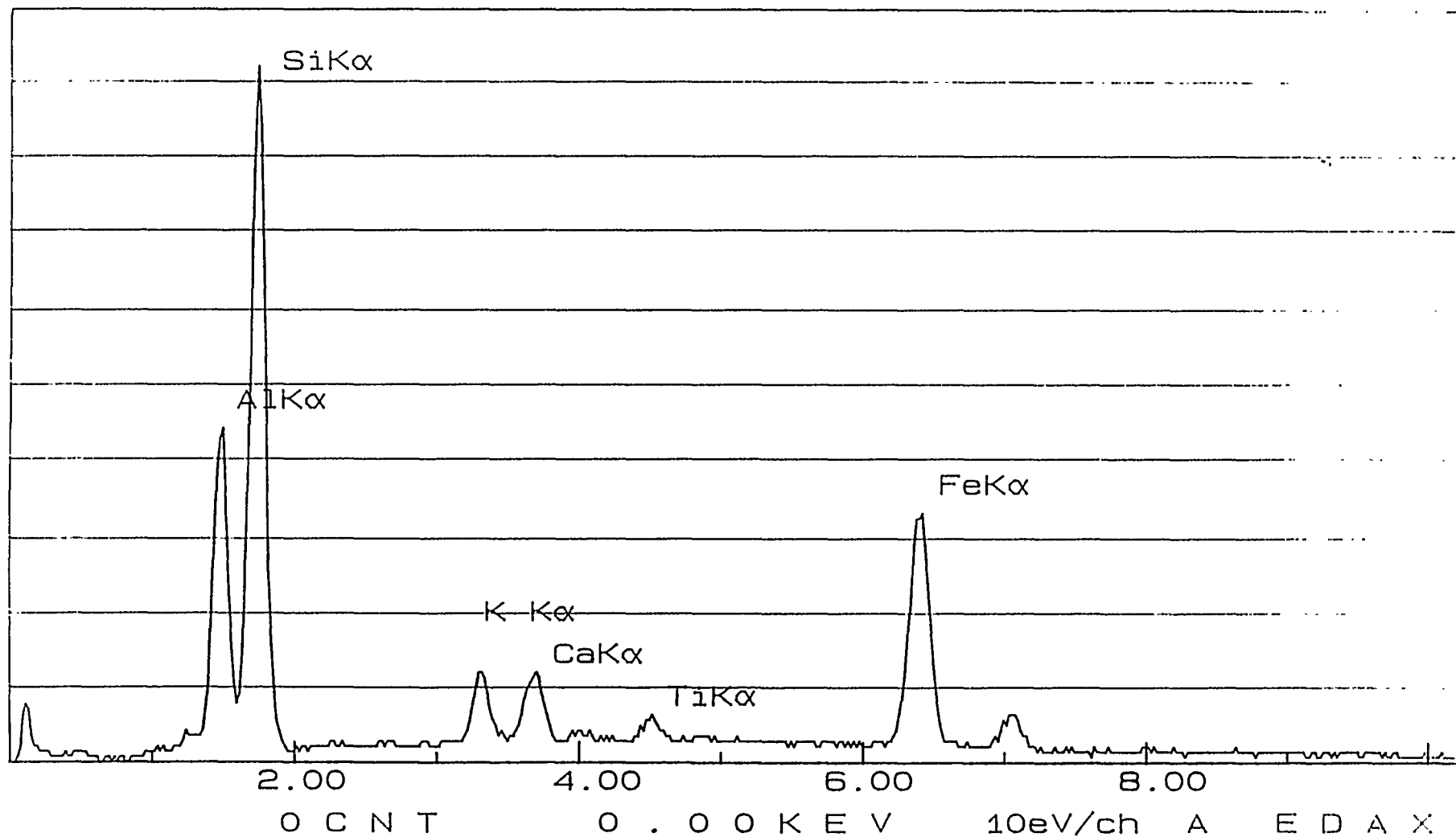
27 - AUG - 92 15:46:47 EDAX READY  
RATE = 0 CPS TIME = 100 LSEC  
FS = 9233 CNT PRST = 150 LSEC  
B = 66 - 214 FILTER



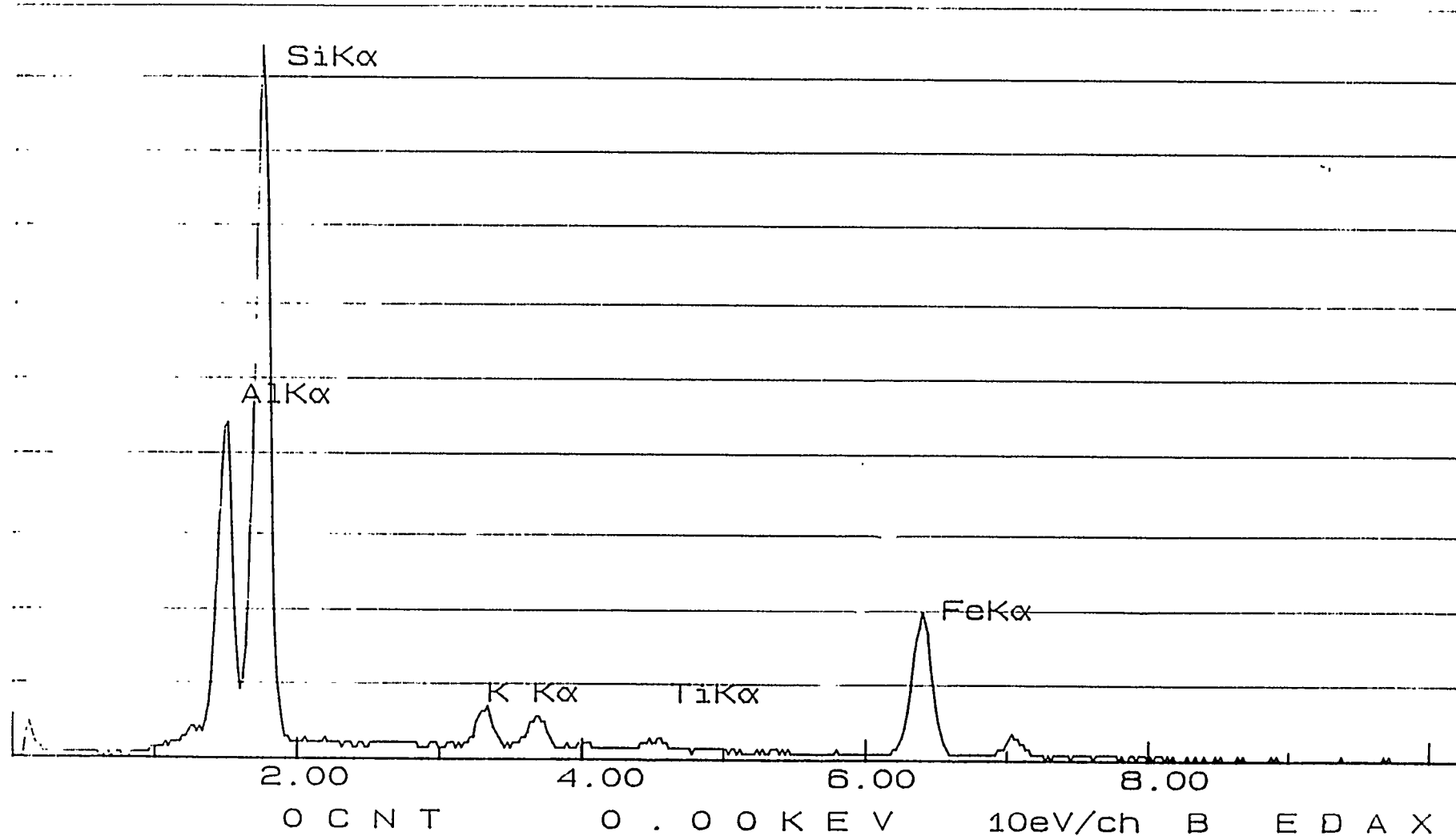
27 - AUG - 92 15:30:08 EDAX READY  
RATE = 0 CPS TIME = 128 LSEC  
FS = 2914 CNT PRST = 150 LSEC  
B = 66 - 213 FILTER



27 - AUG - 92 14:26:24 EDAX READY  
RATE = 2 CPS TIME = 150 L SEC  
FS = 4316 CNT PRST = 150 L SEC  
A = 66 - 212 FILTER

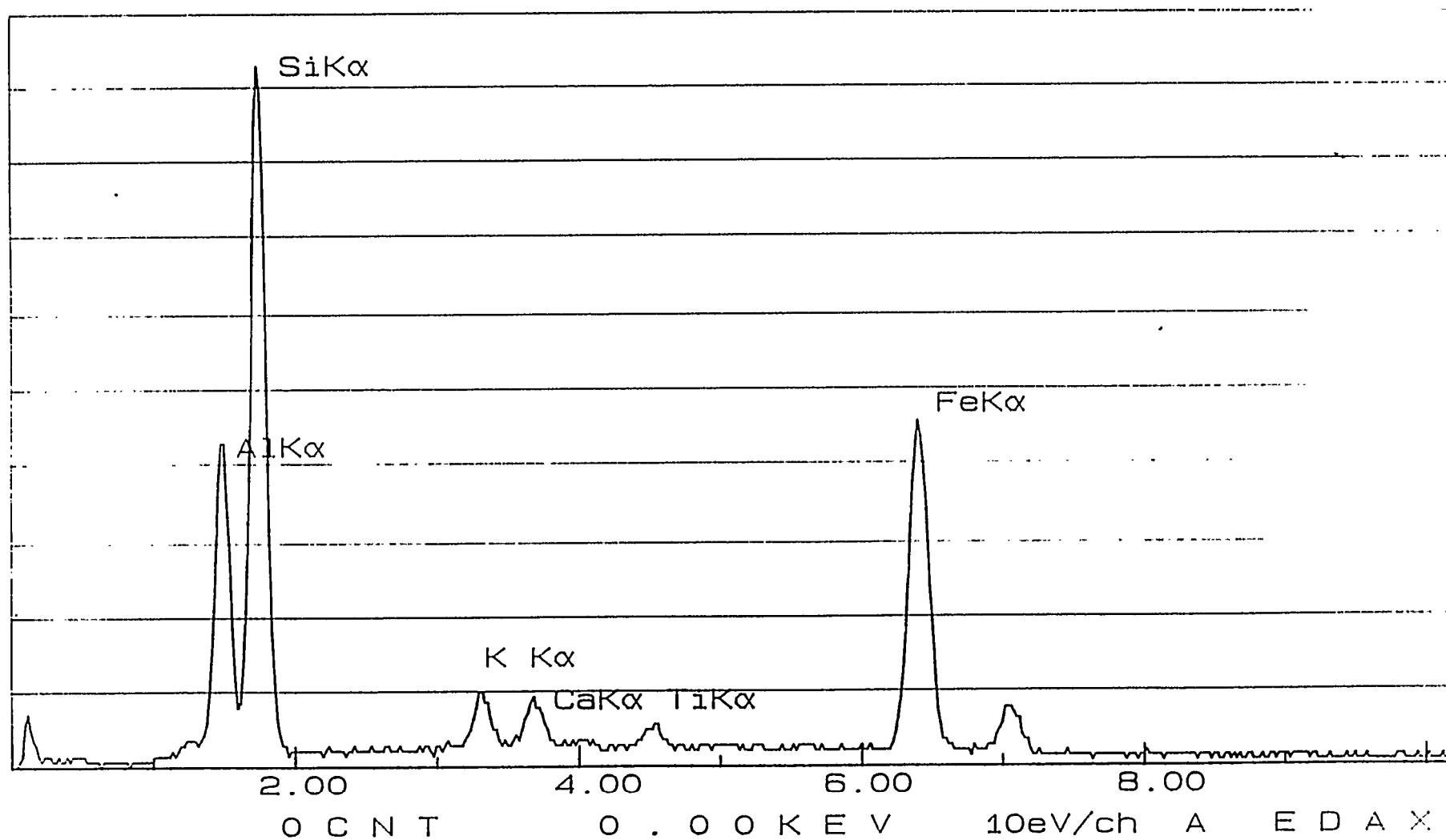


27 - AUG - 92 14:53:17 EDAX READY  
RATE = 3 CPS TIME = 97 LSEC  
FS = 6852 CNT PRST = 150 LSEC  
B = 66 - 210 FILTER

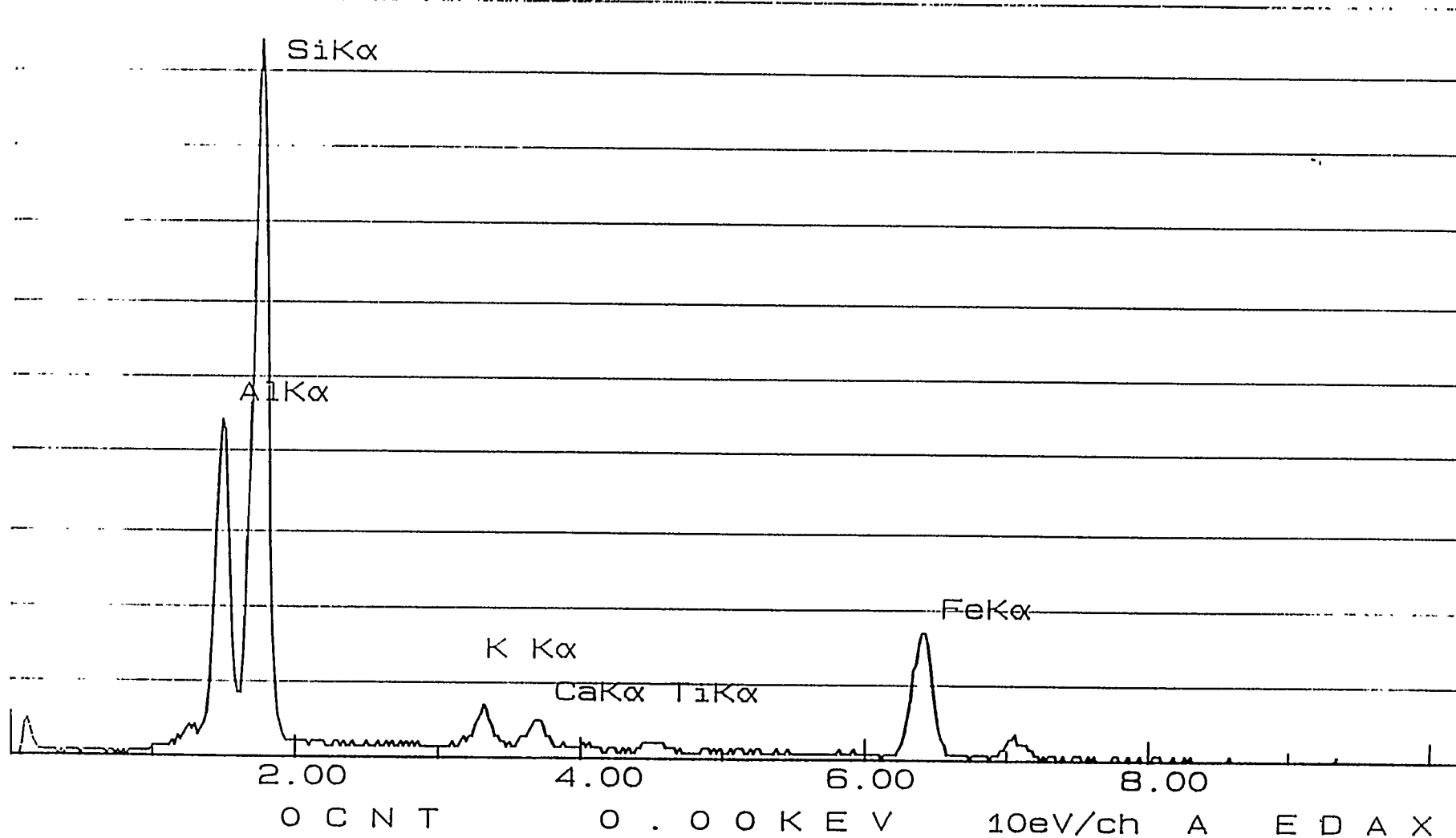




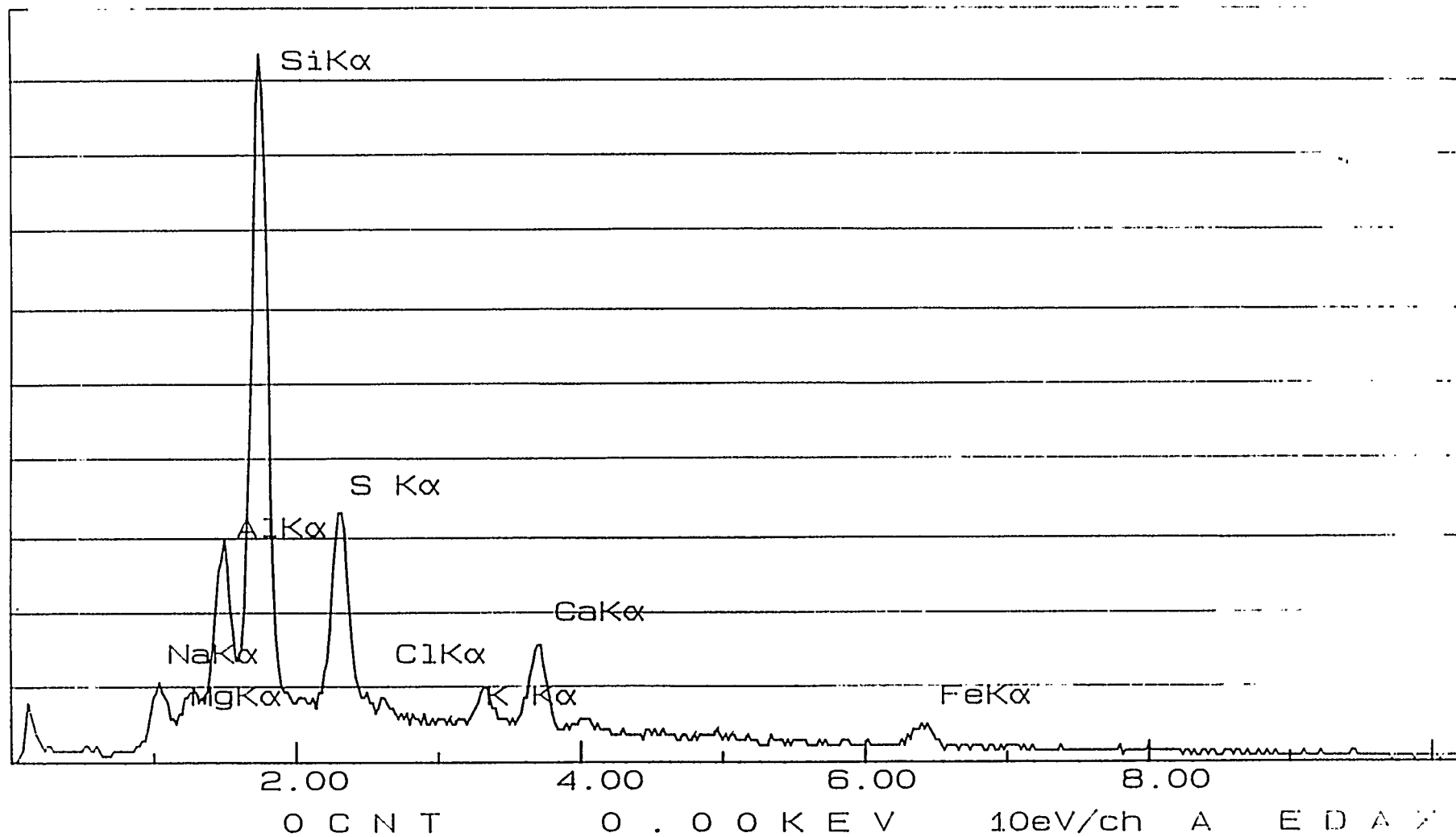
27 - AUG - 92 14:20:59 EDAX READY  
RATE = 3 CPS TIME = 103 L SEC  
FS = 3284 CNT PRST = 150 L SEC  
A = 66 - 208 FILTER



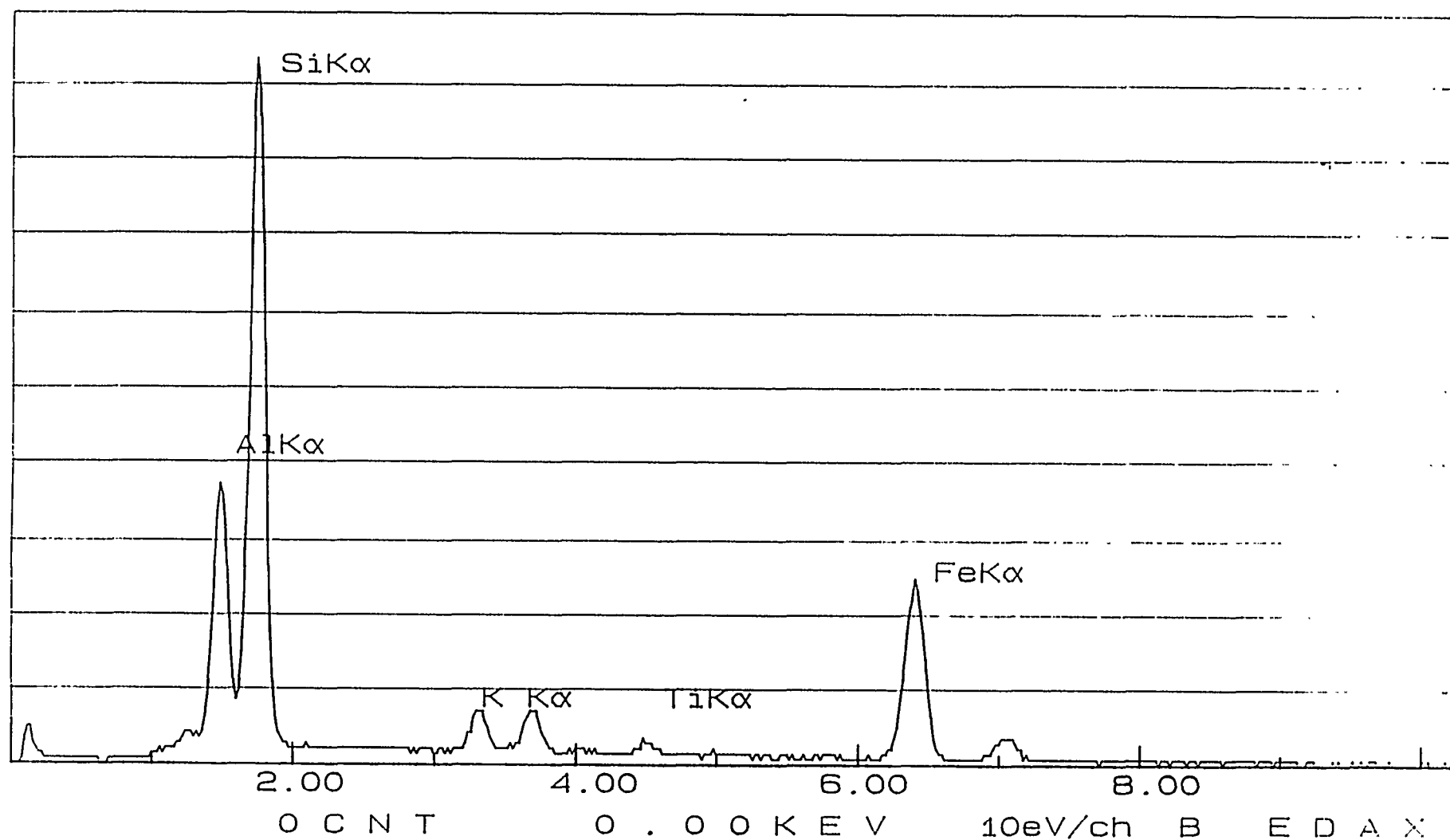
27 - AUG - 92 14:16:20 EDAX READY  
RATE = 12 CPS TIME = 101 LSEC  
S = 3423 CNT PRST = 150 LSEC  
A = 66 - 207 FILTER



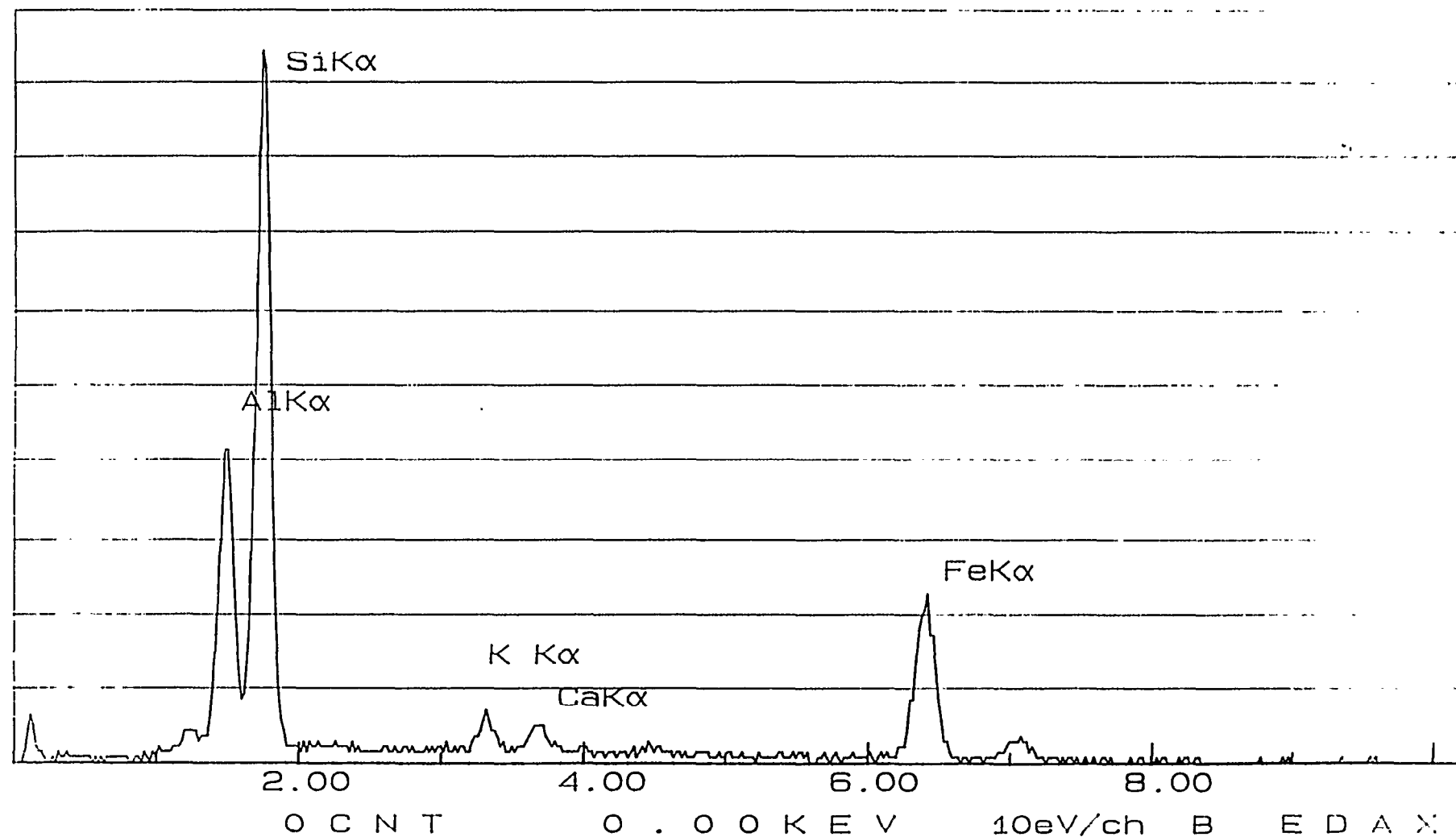
02-SEP-92 08:48:19 EDAX READY  
RATE = 5 CPS TIME = 64 LSEC  
FS = 3802 CNT PRST = 300 LSEC  
A = 66-127 FILTER



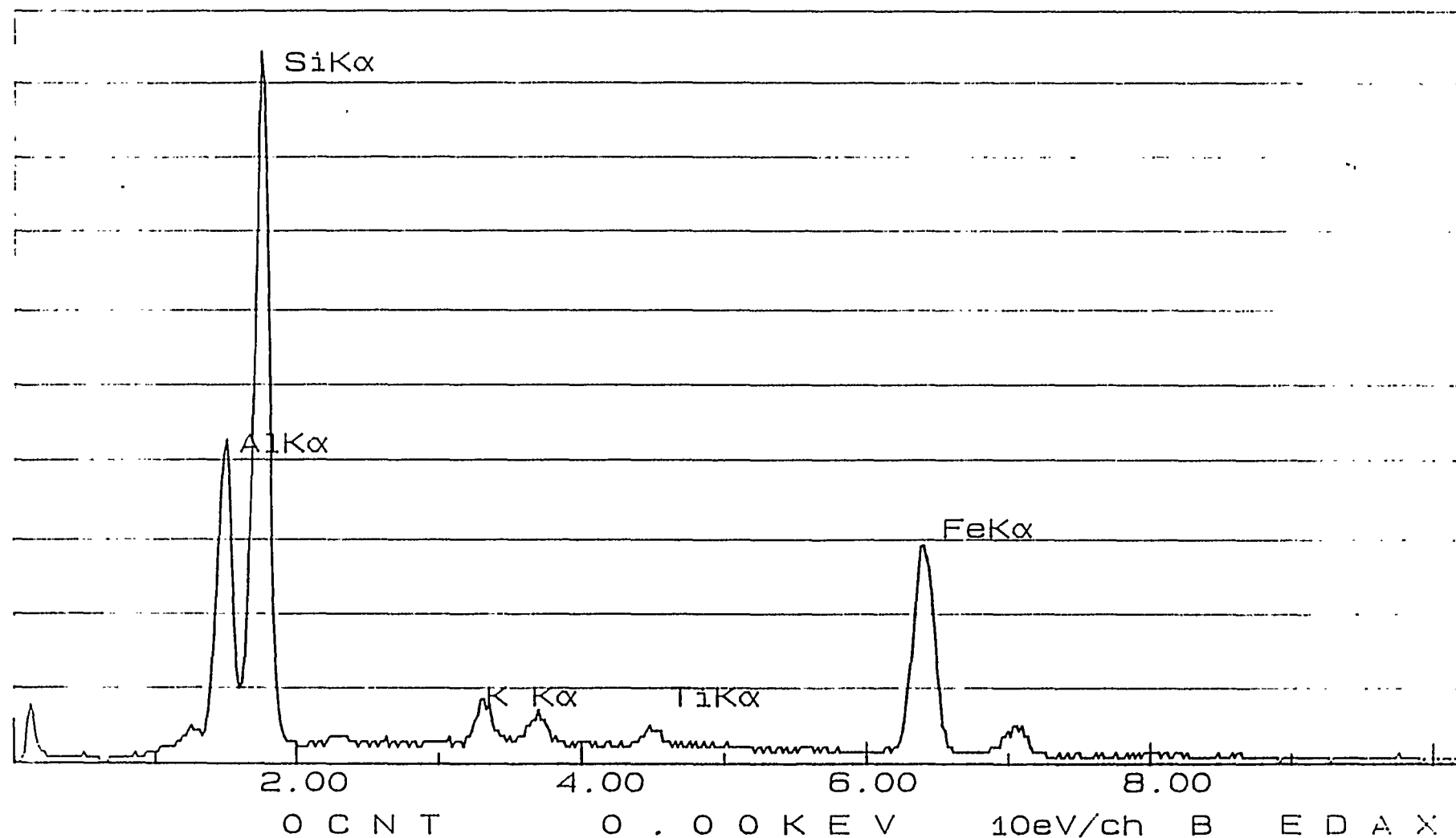
27 - AUG - 92 14:37:21 EDAX READY  
RATE = 6 CPS TIME = 100 LSEC  
FS = 6505 CNT PRST = 150 LSEC  
B = 66 - 200 FILTER



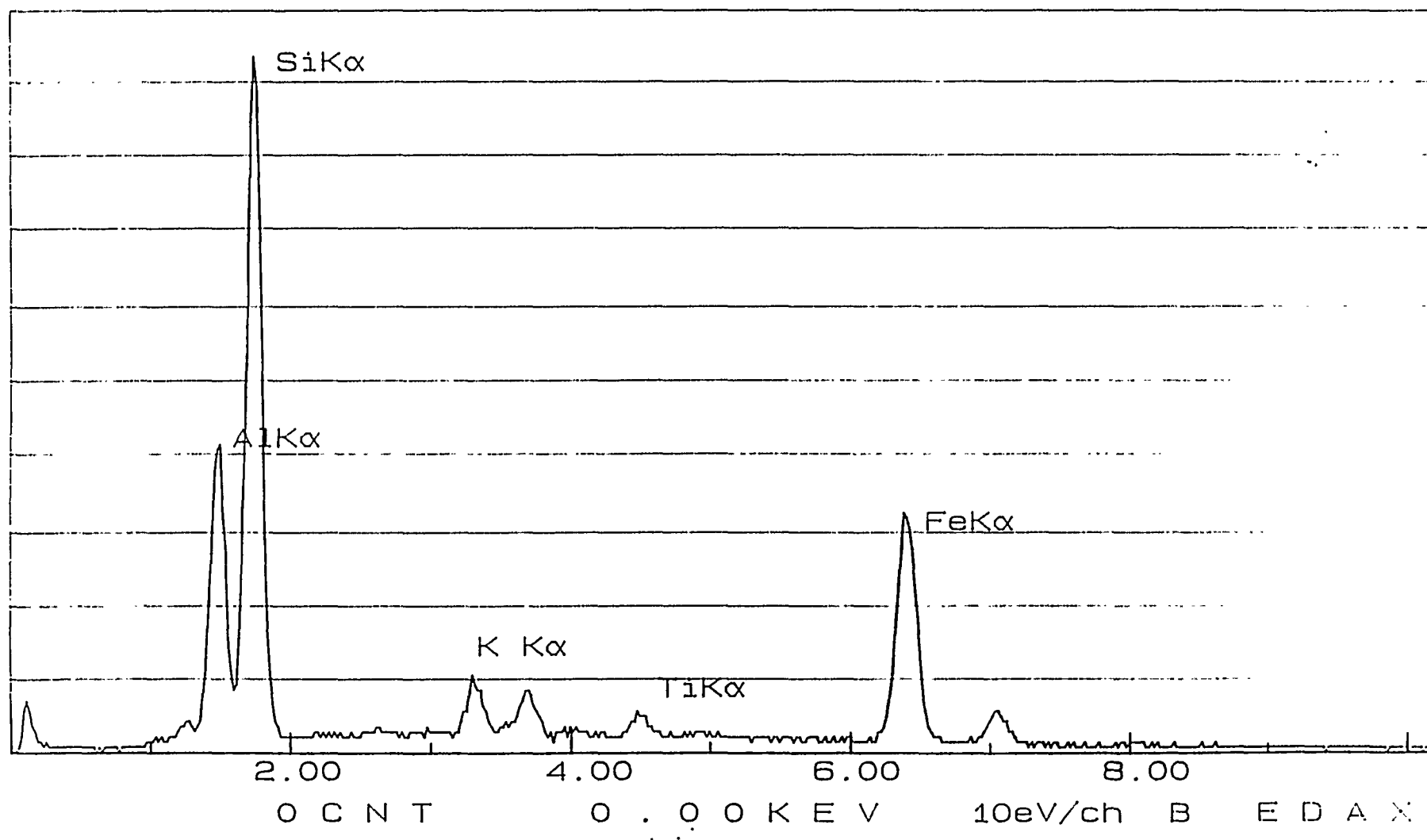
27 - AUG - 92 15:52:10 EDAX READY  
RATE = 3 CPS TIME = 37 L SEC  
FS = 1353 CNT PRST = 150 L SEC  
B = 66 - 199 FILTER



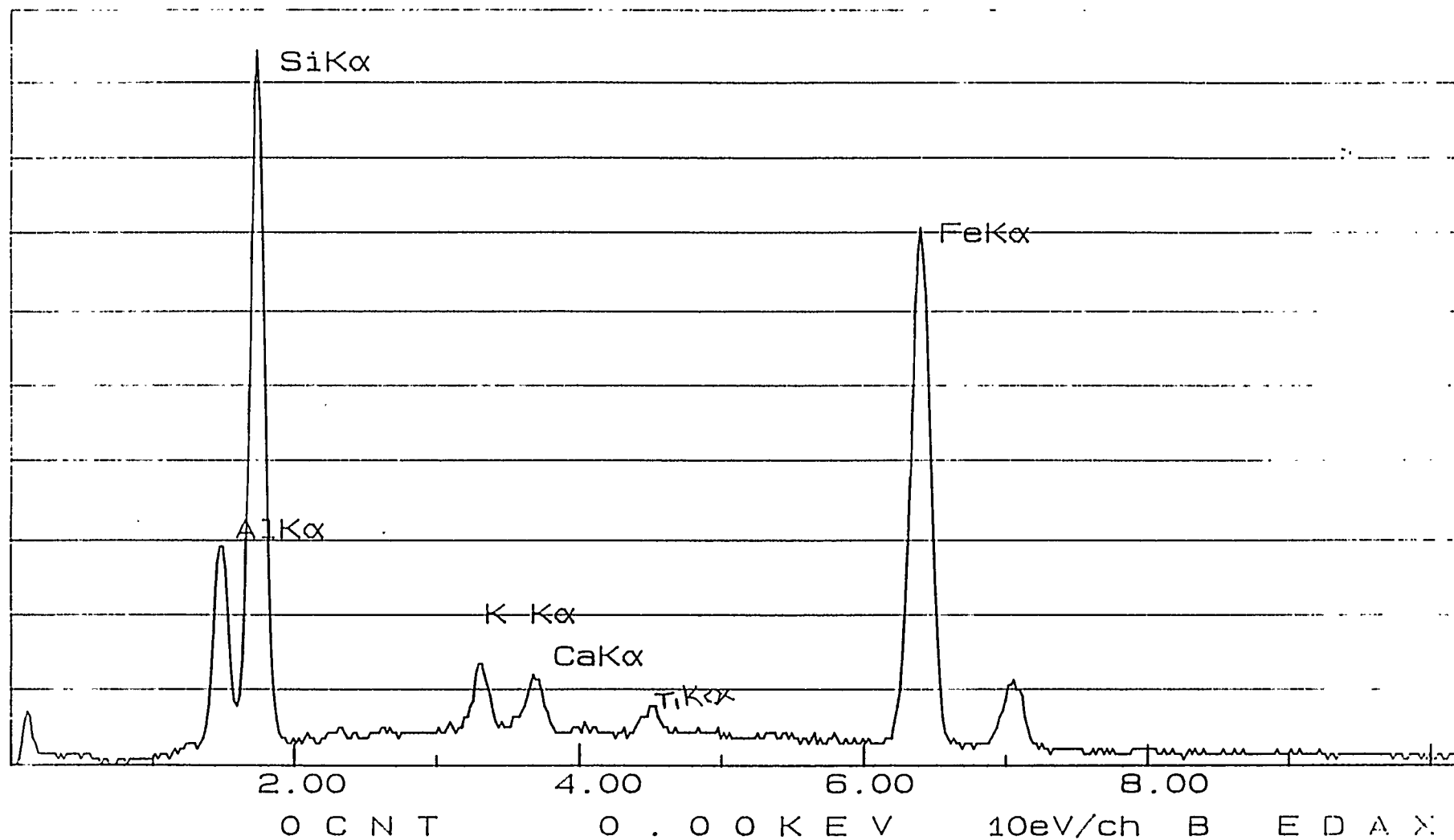
27 - AUG - 92 14:48:44 EDAX READY  
RATE = 0 CPS TIME = 83 L SEC  
FS = 3097 CNT PRST = 150 L SEC  
B = 67 - 150 FILTER



27.- AUG - 92 14:44:16 EDAX READY  
RATE = 5 CPS TIME = 79 LSEC  
FS = 3665 CNT PRST = 150 LSEC  
B = 67 - 149 FILTER



27 - AUG - 92 15:41:42 EDAX READY  
RATE = 0 CPS TIME = 124 LSEC  
FS = 3750 CNT PRST = 150 LSEC  
B = 67 - 148 FILTER CATEGORY







Volume Sandblast Material Used

Date: 7-14-92

Location: Titan Drydock

Purpose: PM-10 Study

Objective: Calculate on the half hour the number of pounds sanblast used during that half hour. Start at 2000 at end at shift completion.

Time	# Nozzles	#lbs Blast Material Consumed
ex.1800to 1830	28	
2000	35	16,968 LBS.
2030	35	16,954 LBS.
2100	32	14,700 LBS.
2130	32	14,700 LBS.
2200	32	14,700 LBS.
2230	32	14,700 LBS.
2300	32	14,700 LBS.
2330	0	0
2400	32	14,700 LBS.
0030	32	14,700 LBS.
0100	32	14,700 LBS.
0130	32	14,700 LBS.
0200	32	14,700 LBS.
0230	32	14,700 LBS.
0300	32	14,700 LBS.
0330	32	14,700 LBS.
0400	32	14,700 LBS.
0430	32	14,700 LBS.
0500	32	14,700 LBS.
0530	32	14,700 LBS.
0600	32	14,700 LBS.
0630	32	14,700 LBS.
0700		14,700 LBS.

Total Estimated square footage removed during shift

22,373 Square Footage



## Average Pressure Supplied to Blasting Head

Date: 7-14-92

Location: Titan DrydockPurpose: PM-10 Study

Time	Average Pressure at Nozzles
2000	90 PSI
2100	95 PSI
2200	110 PSI
2300	105 PSI
2400	85 PSI
0100	100 PSI
0200	105 PSI
0300	95 PSI
0400	90 PSI
0500	100 PSI
0600	110 PSI
0700	



**Meteorological Conditions**

Date: 7-17-52

Location: Titan Drydock

Purpose: PM-10 Study

Time	Wind Direction	Speed	Temp.	% Humidity	
1800	330	240	10 kt.	95°	40 %
1830		240	8 kt.	95°	42 %
1900		240	8 kt.	94°	45 %
1930		240	6 kt.	94°	48 %
2000		240	8 kt.	93°	48 %
2030		220	6 kt.	92°	53 %
2100		250	6 kt.	91°	56 %
2130		240	5 kt.	90°	65 %
2200		220	10 kt.	89°	67 %
2230		250	11 kt.	88°	67 %
2300		255	12 kt.	88°	67 %
2330		230	8 kt.	87°	66 %
2400		230	10 kt.	86°	70 %
0030		255	15 kt.	85°	73 %
0100		230	8 kt.	85°	73 %
0130		235	10 kt.	84°	76 %
0200		230	10 kt.	84°	76 %
0230		255	13 kt.	84°	80 %
0300		245	16 kt.	84°	80 %
0330		270	13 kt.	84°	84 %
0400	240	12 kt.	83°	88 %	
0430	270	14 kt.	83°	92 %	
0500	270	10 kt.	82°	88 %	
0530	255	11 kt.	81°	92 %	
0600	240	12 kt.	82°	72 %	
0630	265	13 kt.	82°	65 %	
0700					
0730					
0800					

**NORSHIPCO**

NORFOLK SHIPBUILDING &amp; DRYDOCK CORPORATION

PO BOX 2100  
NORFOLK VIRGINIA 23501-2100  
Telex: 823 613 Cable: NORSHIPCO  
Telephone: 804/494-4000

## Meteorological Conditions

Date: 7-13-92Purpose: PM-10 Background

Time	Wind	Direction	Speed, K <sub>nots</sub>
1800	W	240	5
1900	W	270	5
2000	W	270	4
2100	W	270	2
2200	W	260	2
2300	W	280	2
2400	W	240	4
July 14, 1992			
0100	W	250	4
0200	W	270	5
0300	W	250	8
0400	W	260	8
0500	W	260	8
0600	W	250	5
0700	W	260	8
0800	W	250	10
0900	W	270	10
1000	W	250	8
1100	W	250	8
1200	W	250	10
1300	W	250	10
1400	W	270	8
1500	W	270	8
1600	W	270	8
1700	W	270	8

*Tom Beaulieu*  
7-3-92

**Appendix D**  
**Field Summary Logs**



# Indian Valley Industries, Inc.

DESERT STORM TAN/BLACK  
(100% fire retardant polypropylene)

WEIGHT	5 oz/yd <sup>2</sup>
SHADE PERCENTAGE	72%
AIR POROSITY	377 cfm
TENSILE STRENGTH Grab Method	Warp: 267 lbs Fill: 116 lbs
ELONGATION % Grab Method	Warp: 15% Fill: 13%
PUNCTURE	110 lbs
TEAR STRENGTH Trapezoid Method	Warp: 113 lbs Fill: 39 lbs
HURST STRENGTH Mullen	327 lbs/in <sup>2</sup>

CONTAINMENT 80% to 85%

DISTRIBUTED BY:



2001-B Trade St.  
Chesapeake, VA 23323  
(804) 487-1055

# EMISSION TESTING FIELD PROJECT SUMMARY LOG



CLIENT Norshipco PROJECT NO. 1512-001  
PLANT Norshipco CITY Norfolk STATE VA

DATE/TIME	ACTION TAKEN
7/13/92	
4:30pm	Arrive on site. Met w/ T. Beachum
6:00pm	Arrive off-site warehouse. Set-up TSP and PM <sub>10</sub> samplers (Runs 1A and 1B)
7/14/92	
9:00am	Arrive on site. Met w/ T. Beachum + blasting crew supervisor. Toured drydock area. Left site 10:30am
3:00pm	Arrive on site. Met w/ T. Beachum + Laurel Driver & Roy Huttley (EPA). Toured drydock area. Sample locations were discussed and selected with EPA representatives
7:00pm	Arrive off-site warehouse. Collected filters for runs 1A and 1B
7:30pm	Arrive on-site. Assembled filter cassettes in drydock office. Assembled samplers.
8:30pm	Joined by T. Beachum and L. Driver/R. Huttley of EPA. Positioned samplers at positions 2 and 4
Page <u>1</u> of <u>3</u> SIGNATURE <u>E Rose</u>	

# EMISSION TESTING FIELD PROJECT SUMMARY LOG



CLIENT Norshipco PROJECT NO. 1512-001  
 CLIENT Norshipco CITY Norfolk STATE VA

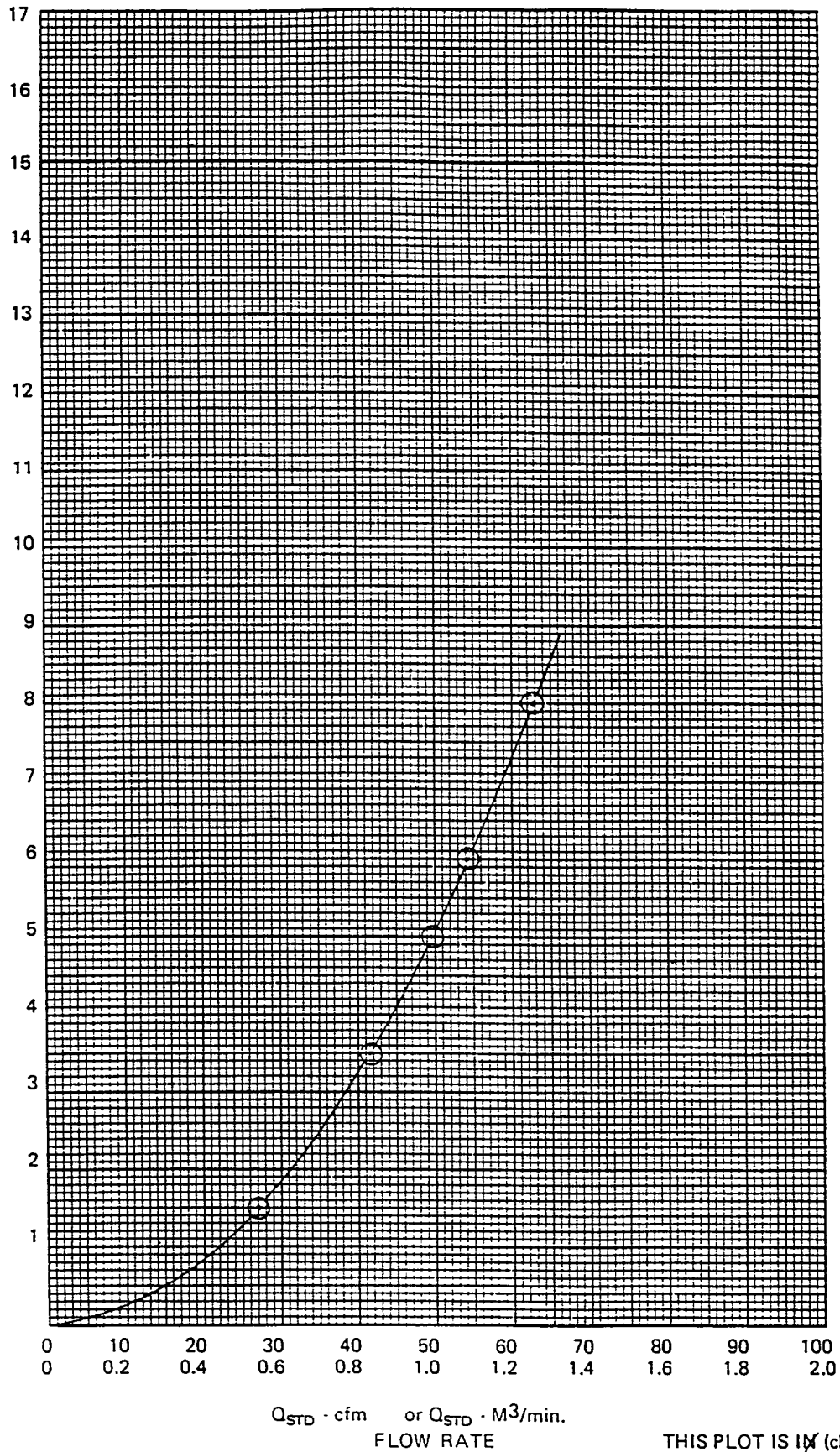
DATE/TIME	ACTION TAKEN
7/14/92 10:00pm	Started runs 2A & 2B
10:15pm	Completed runs 2A & 2B
10:23pm	Started runs 2C & 2D
10:33pm	Completed runs 2C & 2D. Checked PM <sub>10</sub> head for particle trailing.
10:35pm	Started runs 2E & 2F. EPA officials leave site with T. Beachum
10:45pm	Completed runs 2E & 2F. Noticed tears on filters 2G & 2H. Returned to dock office to prepare more filter cassettes.
11:55pm	Started runs 2I and 2J while Pat Slater started runs 3A and 3B.
7/15/92 12:05am	Completed runs 2I and 2J. Pat Slater completed runs 3A, 3B, 3C and 3D. Moved to location 4
12:45am	Started runs 4A & 4B. Noticed tears in filters. <sup>Voided</sup> Runs. Moved samplers to new locations. Returned to dock office to assemble more filter cassettes
Page <u>2</u> of <u>3</u>	SIGNATURE <u>E. [Signature]</u>



## **Appendix E**

### **Equipment Calibrations**

CALIBRATOR ORIFICE STATIC PRESSURE  
 $\Delta H$  - in. of  $H_2O$



THIS PLOT IS ☒ (check one)  
 cfm \_\_\_\_\_  
 M<sup>3</sup>/min. \_\_\_\_\_  
 They are NOT EQUIVALENT

# HIGH VOLUME SAMPLER CALIBRATION WORKSHEET

Site location Nordhagen # 1512-001  
 Date 7/13/92  
 Collected by: P. Stiller / E. Rone  
 (2) Temperature,  $T_2$  (K) 295.2  
 Sample No. CAE 2945  
 Transfer std type: Orifice  
 Serial No. 11-2

Optional Average barometric pressure: $P_a =$ _____ Seasonal average temperature: $T_s =$ _____ $P_{10} = 760 \text{ mm Hg (or } 29.92 \text{ in.)}$		For specific pressure and temperature corrections (see Table 2.1) $\sqrt{1 \left( \frac{P_a}{P_2} \right) \left( \frac{T_2}{T_s} \right)}$ or $\sqrt{1 \left( \frac{P_a}{P_2} \right) \left( \frac{T_2}{T_s} \right)}$		For incorporation of average pressure and seasonal average temperature (see Table 2.1) $\sqrt{1 \left( \frac{P_a}{P_2} \right) \left( \frac{T_2}{T_s} \right)}$ or $\sqrt{1 \left( \frac{P_a}{P_2} \right) \left( \frac{T_2}{T_s} \right)}$	
No.	$\Delta H$ Pressure drop across orifice (in) or (cm)	$\sqrt{\Delta H \left( \frac{P_a}{P_2} \right) \left( \frac{T_2}{T_s} \right)}$	$Q_{air}$ (from orifice certification std. m <sup>3</sup> /min)	Sampler flow rate indication (arbitrary)	
1	1.5	0.764	0.764	20	
2	3.5	1.172	1.172	34	
3	5.0	1.398	1.398	46	
4	6.0	1.534	1.534	52	
5	8.0	1.777	1.777		
6					

## Least Squares Calculations

Linear regression of Y on X:  $Y = mX + b$ ; Y = appropriate expression from Table 2.1; X =  $Q_{air}$

Slope (m) = 41.99606 Intercept (b) = -12.3032 Correlation Coefficient (r) = \_\_\_\_\_

To determine subsequent flow rate during use:  $X = 1/m (Y-b)$

$Q_{air} = 1/m$  [appropriate expression from Table 2]  $\cdot b$

# CALIBRATION WORK SHEET

**Q<sub>STD</sub>**

								For application ref. 1 (9)
(1) Run Point No.	(2) Elapsed Time - Δt Min.	(3) Initial Volume V <sub>m</sub> M <sup>3</sup>	(4) Meter Inlet Static Pressure-ΔP mm of Hg	(5) Standard Volume V <sub>STD</sub> M <sup>3</sup>	(6) Calibrator Orifice Static Press. ΔH in. of H <sub>2</sub> O	(7) Metric Flow Rate Q <sub>STD</sub> M <sup>3</sup> /min.	(8) English Flow Rate Q <sub>STD</sub> ft <sup>3</sup> /min.	$\sqrt{\Delta H \left( \frac{P_a}{P_{STD}} \right) \left( \frac{298}{T_A} \right)}$
1	1.338	1	4.0	1.022	1.5	0.764	27.0	
2	0.866	1	9.3	1.015	3.5	1.172	41.4	
3	0.722	1	13.2	1.009	5.0	1.398	49.4	
4	0.655	1	15.9	1.006	6.0	1.536	54.2	
5	0.562	1	21.2	0.999	8.0	1.777	62.8	
6								
7								

$$V_{STD} = V_m \frac{(P_a - \Delta P) T_{STD}}{P_{STD} T_a}$$

$$Q_{STD} = \frac{V_{STD}}{\Delta t}$$

$$M^3 \times 35.31 = Ft^3$$

(7) and (8) are corrected to  
760 mm of Hg  
25° mm (298°K)

**Q<sub>a</sub>**

							For application see ref. 2 (8a)
(1) Run oint No.	(2) Elapsed Time - Δt Min.	(3) Initial Volume V <sub>m</sub> M <sup>3</sup>	(4) Meter Inlet Static Pressure-ΔP mm of Hg	(5a) Actual Volume V <sub>a</sub> M <sup>3</sup>	(6) Calibrator Orifice Static Press. ΔH in. of H <sub>2</sub> O	(7a) Metric Flow Rate Q <sub>a</sub> M <sup>3</sup> /min.	$\sqrt{\Delta H \left( \frac{T_A}{P_A} \right)}$
1	1.338	1	4.0		1.5		
2	0.866	1	9.3		3.5		
3	0.722	1	13.2		5.0		
4	0.655	1	15.9		6.0		
5	0.562	1	21.2		8.0		
6							
7							

$$V_a = V_m \frac{(P_A - \Delta P)}{P_A}$$

$$Q_a = \frac{V_a}{\Delta t}$$

(9) P<sub>a</sub> 775.2 mm of Hg

Roots Meter No.: 7509364  
Calibrator Orifice:

(10) T<sub>a</sub> 23 °C + 273 = °K

Model No.: VRC

(11) RH: 54 %

Serial No.: V2

Calibration performed by:

J. Lazare

Calibration Code 30-3-2010

Date placed in service: 11-12-90  
(To be noted by user) JCB

Additional information consult:

1. The Federal Register, Vol. 47, No. 234, pp. 54896-54921, December 6, 1982
2. Quality Assurance Handbook, Vol. II (EPA 600/4-77-027a), Section 2.11

Notes: 1 EPA recommends calibrators should be recalibrated after one year of field use.  
2. Copies of this calibration are not kept on file.

## HIGH VOLUME SAMPLER CALIBRATION WORKSHEET

Station	Marshico # 1512-001
Date	7/13/92
Calculated by	P. Slicker/E. Poore
Sample No	5
Transfer and type	Office
Serial No.	
Serial No.	V-2
(1) Barometric pressure, P (mm Hg (or in.))	29.4
(2) Temperature, T (K)	295.2

Optional		$P_{atm} = 760 \text{ mm Hg (or } 29.92 \text{ in.)}$ Average barometric pressure: $P_a =$ _____ Seasonal average temperature: $T_a =$ _____	
1	$\Delta H$ Pressure drop across orifice (in) or (cm)	$\sqrt{\Delta H \left( \frac{P_a}{P_2} \right) \left( \frac{298}{T_2} \right)}$	(X) $Q_{air}$ (from orifice coefficient std. m <sup>3</sup> /min
2	30	0.764	1.772
3	43	1.398	1.536
4	58	1.536	1.772
5	67		

### Least Squares Calculations

Linear regression of  $\hat{Y}$  on  $X$ :  $\hat{Y} = mX + b$ ;  $\hat{Y}$  = appropriate expression from Table 2.1;  $X = Q_{1n}$

$$\text{Slope (m)} = \frac{1.560376}{1.12758439} = 1.3837$$

To determine subsequent flow rate during use:  $X = 1/m (N-b)$

$$Q_{11} = 1/m \text{ (appropriate expression from Table 2) } \cdot b/$$

HIGH VOLUME SAMPLER CALIBRATION WORKSHEET

Site location: Nor Shripco # 1512-001

7/13/92

Controlled by: P. Slater / E. Poore

Sample No. 4

Transfer sid type: Office

**Serial No.**

$\checkmark - 2$

(1) Barometric pressure,  $P$  (mm Hg (or in.))

(2) Temperature,  $T_2$  (K) 295.2

**Serial No.**

0

[illegible]

Linear: regression of  $Y$  on  $X$ :  $Y = mX + b$ ;  $Y$  = appropriate expression from Table 2.1;  $X = Q_{10}$

$$\text{Slope (m)} = 38.0625 \quad \text{Intercept (b)} = -5.19079$$

$Q_{11} = 1/m$  {appropriate expression from Table 2}  $\cdot b)$

To determine subsequent flow rate during use:  $X = 1/m(N \cdot b)$

# HIGH VOLUME SAMPLER CALIBRATION WORKSHEET

Site location Norshipco # 1512-001  
 Date 7/13/92 (1) Barometric pressure,  $P_2$  mm Hg (or in.) 756  
 Calibrated by P. Slater / E. Poore (2) Temperature,  $T$  (K) 295.2  
 Sampler No. 3 Serial No. \_\_\_\_\_  
 Transfer std type Orifice Serial No. V-2

$P_{std} = 760 \text{ mm Hg (or 29.92 in.)}$ Optional. Average barometric pressure: $P_a =$ _____ Seasonal average temperature: $T_s =$ _____					5 (Y)	
					For specific pressure and temperature corrections (see Table 2.1),	For incorporation of average pressure and seasonal average temperature (see Table 2.1)
no	1 $\Delta H$ Pressure drop across orifice (in) or (cm)	$\sqrt{\Delta H \left( \frac{P_2}{P_{std}} \right) \left( \frac{298}{T_2} \right)}$	(X) 3 $Q_{std}$ (from orifice certification std. $m^3/min$ )	4 1 Sampler flow rate indication (arbitrary)	<input checked="" type="checkbox"/> 1 or <input type="checkbox"/> $\sqrt{1 \left( \frac{P_2}{P_{std}} \right) \left( \frac{298}{T_2} \right)}$ or <input type="checkbox"/> $\sqrt{\left( \frac{P_2}{P_{std}} \right) \left( \frac{298}{T_2} \right)}$	<input type="checkbox"/> 1 or <input type="checkbox"/> $\sqrt{1 \left( \frac{P_2}{P_a} \right) \left( \frac{T_s}{T_2} \right)}$ or <input type="checkbox"/> $\sqrt{\left( \frac{P_2}{P_a} \right) \left( \frac{T_s}{T_2} \right)}$
1	1.5		0.764	22		
2	3.5		1.172	38		
3	5.0		1.398	48		
4	6.0		1.534	50		
5	8.0		1.777	62		
6						

## Least Squares Calculations

Linear regression of Y on X:  $Y = mX + b$ ; Y = appropriate expression from Table 2.1;  $X = Q_{std}$

Slope (m) = 37.23434 Intercept (b) = -4.53625 Correlation Coefficient (r) = \_\_\_\_\_

To determine subsequent flow rate during use:  $X = 1/m (Y - b)$

$Q_{std} = 1/m [\text{appropriate expression from Table 2}] - b)$

# HIGH VOLUME SAMPLER CALIBRATION WORKSHEET

Site location Norah: pcc # 1512-001  
 Date 7/13/92 (1) Barometric pressure,  $P_2$  (mm Hg) (or in.) 754  
 Calibrated by: P. Slater / E. Poore (2) Temperature,  $T_2$  (K) 295.2  
 Sampler No. 2 Serial No. \_\_\_\_\_  
 Transfer std type: Orifice Serial No. V-2

Optional: $P_{std} = 760 \text{ mm Hg (or 29.92 in.)}$ Average barometric pressure: $P_s =$ _____ Seasonal average temperature: $T_s =$ _____					5 (Y)	
					For specific pressure and temperature corrections (see Table 2.1)	For incorporation of average pressure and seasonal average temperature (see Table 2.1)
No	1 $\Delta H$ Pressure drop across orifice (in) or (cm)	$\sqrt{\Delta H \left( \frac{P_2}{P_{std}} \right) \left( \frac{298}{T_2} \right)}$	(X) 3 $Q_{std}$ (from orifice certification std. $m^3/min$ )	4 1 Sampler flow rate indication (arbitrary)	$\square \sqrt{1 \left( \frac{P_2}{P_{std}} \right) \left( \frac{298}{T_2} \right)}$ or $\square \sqrt{\left( \frac{P_2}{P_{std}} \right) \left( \frac{298}{T_2} \right)}$	$\square \sqrt{1 \left( \frac{P_2}{P_s} \right) \left( \frac{T_s}{T_2} \right)}$ or $\square \sqrt{\left( \frac{P_2}{P_s} \right) \left( \frac{T_s}{T_2} \right)}$
1	1.5		0.764	22		
2	3.5		1.172	39		
3	5		1.398	48		
4	6		1.539	50		
5	8		1.777			
6						

## Least Squares Calculations

Linear regression of Y on X:  $Y = mX + b$ ; Y = appropriate expression from Table 2.1; X =  $Q_{std}$

Slope,  $m =$  37.24351 Intercept (b) = -4.29692 Correlation Coefficient (r) = \_\_\_\_\_

To determine subsequent flow rate during use:  $X = 1/m (Y - b)$

$Q_{std} = 1/m [\text{appropriate expression from Table 2}] - b$



## Summary of Sampler Calibrations

Orifice Qstd	Delta H	Sampler CAE-2945	Sampler 1	Sampler 2	Sampler 3	Sampler 4	5
0.764	1.5	20	20	22	22	24	30
1.172	3.5	34	36	39	38	38	43
1.398	5	46	47	48	48	48	53
1.536	6	52	53	50	50	53	58
1.777	8				62		67
	Y Intercept (b	-12.3032	-12.7681	-4.29697	-4.53625	-5.19079	1.560376
	Slope (m)	41.99606	42.75841	37.24351	37.23434	38.06825	37.03243

# HIGH VOLUME SAMPLER CALIBRATION WORKSHEET

Site location Norshipco #1512-00A  
 Date 7/13/92 (1) Barometric pressure,  $P_1$  (mm Hg (or in.)) 256  
 Calibrated by: P. Slater / E. Poore (2) Temperature,  $T_2$  (K) 295.2  
 Sampler No. 1 Serial No. \_\_\_\_\_  
 Transfer std type Orifice Serial No. V-2

Optional. $P_{std} = 760 \text{ mm Hg (or 29.92 in.)}$ Average barometric pressure: $P_s =$ _____ Seasonal average temperature: $T_s =$ _____					5 (Y)	
					For specific pressure and temperature corrections (see Table 2.1)	For incorporation of average pressure and seasonal average temperature (see Table 2.1)
No	1 $\Delta H$ Pressure drop across orifice (in) or (cm)	$\sqrt{\Delta H \left( \frac{P_2}{P_{std}} \right) \left( \frac{298}{T_2} \right)}$	3 $Q_{std}$ (from orifice certification std. m <sup>3</sup> /min)	4 $I$ Sampler flow rate indication (arbitrary)	<input checked="" type="checkbox"/> 1 or <input type="checkbox"/> $\sqrt{1 \left( \frac{P_2}{P_{std}} \right) \left( \frac{298}{T_2} \right)}$ or <input type="checkbox"/> $\sqrt{\left( \frac{P_2}{P_{std}} \right) \left( \frac{298}{T_2} \right)}$	<input type="checkbox"/> 1 or <input type="checkbox"/> $\sqrt{1 \left( \frac{P_2}{P_s} \right) \left( \frac{T_s}{T_2} \right)}$ or <input type="checkbox"/> $\sqrt{\left( \frac{P_2}{P_s} \right) \left( \frac{T_s}{T_2} \right)}$
1	1.5	1.22	0.764	20		
2	3.5	1.87	1.172	36		
3	5.0	2.24	1.398	47		
4	6.0	2.45	1.536	53		
5	8.0	2.83	1.777	—		
6						

## Least Squares Calculations

Linear regression of Y on X:  $Y = mX + b$ ; Y = appropriate expression from Table 2.1;  $X = Q_{std}$

Slope (m) = 42.75841 Intercept (b) = -12.7681 Correlation Coefficient (r) = —

To determine subsequent flow rate during use:  $X = 1/m (Y - b)$

$Q_{std} = 1/m [\text{appropriate expression from Table 2}] \cdot b$

# EMISSION TESTING FIELD PROJECT SUMMARY LOG



CLIENT Norshipco PROJECT NO. 1512-001  
PLANT Norshipco CITY Norfolk STATE VA

DATE/TIME	ACTION TAKEN
7/15/92 2:00am	Returned to Location 4 and started runs 4C and 4D.
2:10am	Completed runs 4C & 4D. Check PM <sub>10</sub> for particle trailing (none observed). Moved samplers to Location 6.
2:20am	Started runs 5A & 5B
2:25am	Completed runs 5A & 5B
2:45am	Started runs 6A & 6B
2:50am	Completed runs 6A & 6B
	Disassembled filter cassettes. Checked data sheets
	Chain of Custody log. Loaded equipment
4:00am	Left site.
Page <u>3</u> of <u>3</u>	SIGNATURE <u>[Signature]</u>